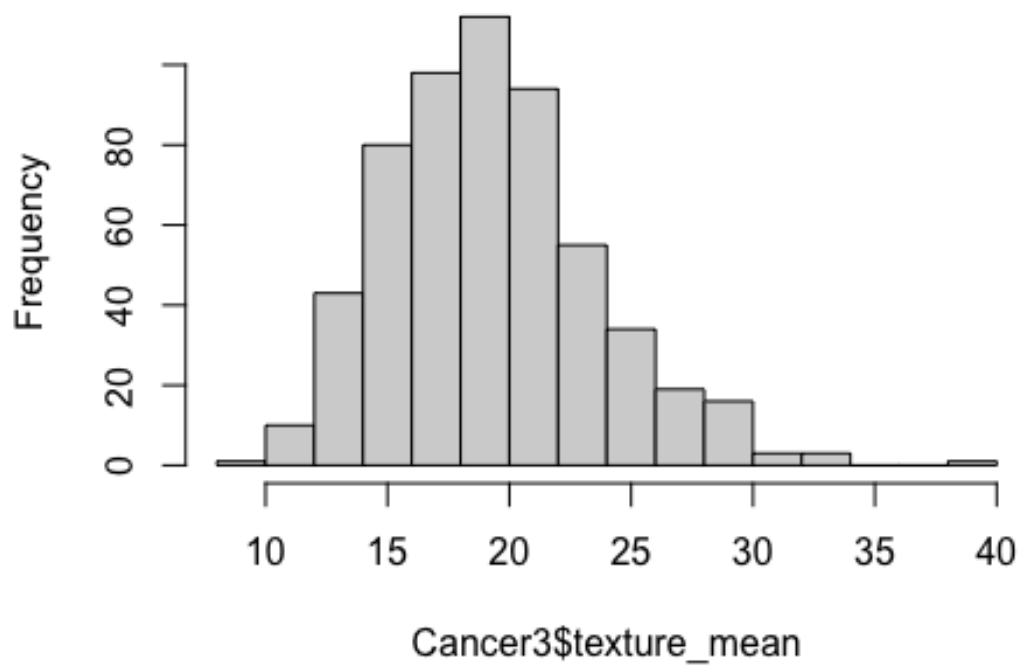# ML Final project Linear and Logistics
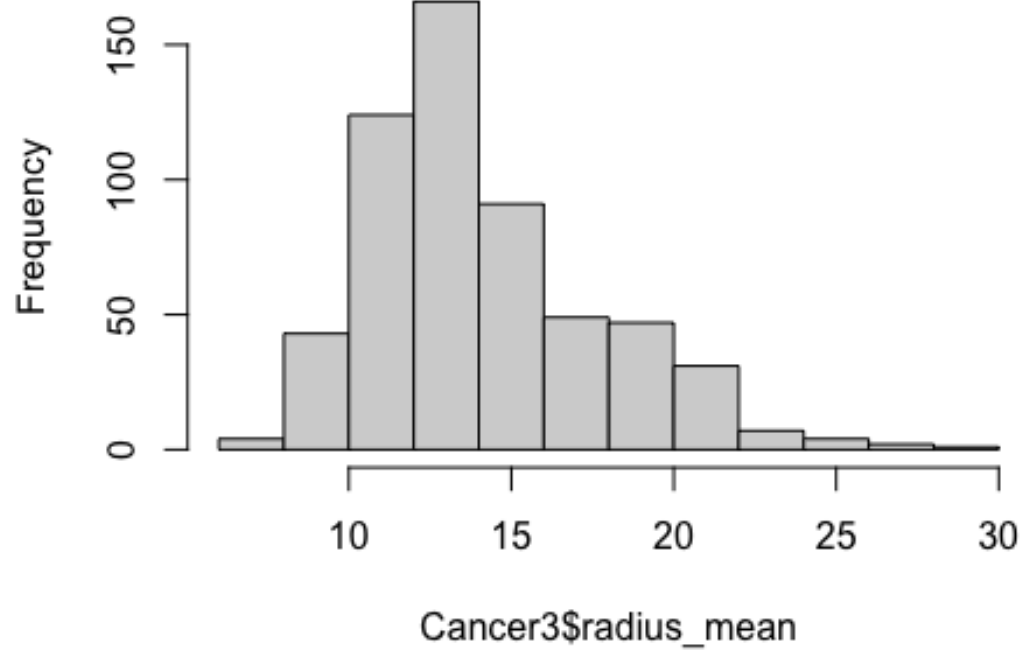
Nawwaf Albahar

2022-12-15

```
options(scipen=999)
set.seed(1)
Cancer3 <- read.csv("/Users/nawwaf/Desktop/Kent/Kent Master_s/Machine
Learning/Final Project/data.csv")
hist(Cancer3$texture_mean)
```
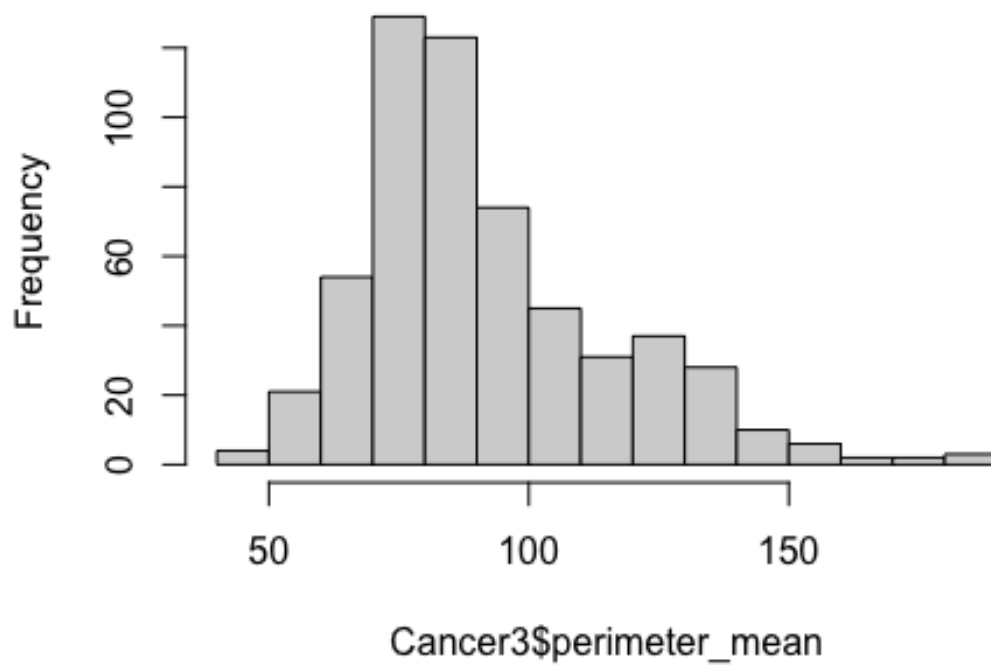

Histogram of Cancer3$texture_mean

```
hist(Cancer3$radius_mean)
```
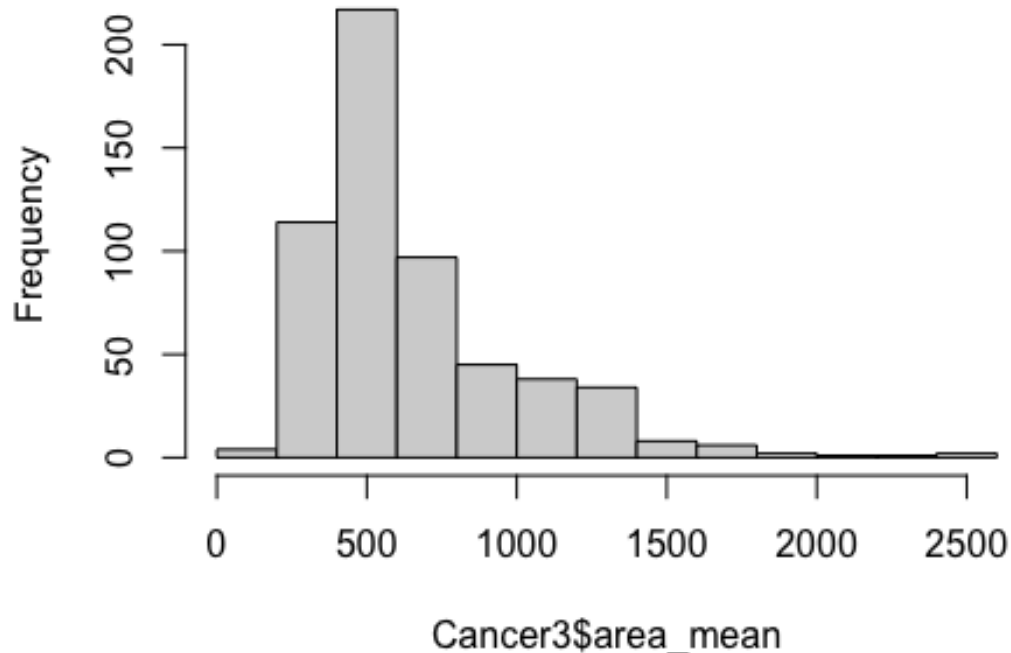
Histogram of Cancer3$radius_mean


```
hist(Cancer3$perimeter_mean)
```

Histogram of Cancer3$perimeter_mean


```
hist(Cancer3$area_mean)
```

Histogram of Cancer3$area_mean

Cancer3$area_mean

```
mean(Cancer3$concavity_worst)

## [1] 0.2721885

summary(Cancer3)

##        id              diagnosis          radius_mean        texture_mean
##  Min.   :     8670   Length:569         Min.   : 6.981    Min.   : 9.71
##  1st Qu.:   869218   Class :character   1st Qu.:11.700    1st Qu.:16.17
##  Median :   906024   Mode  :character   Median :13.370    Median :18.84
##  Mean   : 30371831                      Mean   :14.127    Mean   :19.29
##  3rd Qu.:  8813129                      3rd Qu.:15.780    3rd Qu.:21.80
##  Max.   :911320502                      Max.   :28.110    Max.   :39.28
##  perimeter_mean      area_mean       smoothness_mean    compactness_mean
##  Min.   : 43.79   Min.   : 143.5   Min.   :0.05263   Min.   :0.01938
##  1st Qu.: 75.17   1st Qu.: 420.3   1st Qu.:0.08637   1st Qu.:0.06492
##  Median : 86.24   Median : 551.1   Median :0.09587   Median :0.09263
##  Mean   : 91.97   Mean   : 654.9   Mean   :0.09636   Mean   :0.10434
##  3rd Qu.:104.10   3rd Qu.: 782.7   3rd Qu.:0.10530   3rd Qu.:0.13040
##  Max.   :188.50   Max.   :2501.0   Max.   :0.16340   Max.   :0.34540
##  concavity_mean    concave.points_mean symmetry_mean
fractal_dimension_mean
##  Min.   :0.00000   Min.   :0.00000     Min.   :0.1060   Min.   :0.04996
##  1st Qu.:0.02956   1st Qu.:0.02031     1st Qu.:0.1619   1st Qu.:0.05770
```

```
##  Median :0.06154   Median :0.03350    Median :0.1792   Median :0.06154
##  Mean   :0.08880   Mean   :0.04892    Mean   :0.1812   Mean   :0.06280
##  3rd Qu.:0.13070   3rd Qu.:0.07400    3rd Qu.:0.1957   3rd Qu.:0.06612
##  Max.   :0.42680   Max.   :0.20120    Max.   :0.3040   Max.   :0.09744
##    radius_se        texture_se       perimeter_se       area_se
##  Min.   :0.1115   Min.   :0.3602   Min.   : 0.757   Min.   :  6.802
##  1st Qu.:0.2324   1st Qu.:0.8339   1st Qu.: 1.606   1st Qu.: 17.850
##  Median :0.3242   Median :1.1080   Median : 2.287   Median : 24.530
##  Mean   :0.4052   Mean   :1.2169   Mean   : 2.866   Mean   : 40.337
##  3rd Qu.:0.4789   3rd Qu.:1.4740   3rd Qu.: 3.357   3rd Qu.: 45.190
##  Max.   :2.8730   Max.   :4.8850   Max.   :21.980   Max.   :542.200
##  smoothness_se       compactness_se      concavity_se      concave.points_se
##  Min.   :0.001713   Min.   :0.002252   Min.   :0.00000   Min.   :0.000000
##  1st Qu.:0.005169   1st Qu.:0.013080   1st Qu.:0.01509   1st Qu.:0.007638
##  Median :0.006380   Median :0.020450   Median :0.02589   Median :0.010930
##  Mean   :0.007041   Mean   :0.025478   Mean   :0.03189   Mean   :0.011796
##  3rd Qu.:0.008146   3rd Qu.:0.032450   3rd Qu.:0.04205   3rd Qu.:0.014710
##  Max.   :0.031130   Max.   :0.135400   Max.   :0.39600   Max.   :0.052790
##    symmetry_se        fractal_dimension_se radius_worst     texture_worst
##  Min.   :0.007882   Min.   :0.0008948   Min.   : 7.93   Min.   :12.02
##  1st Qu.:0.015160   1st Qu.:0.0022480   1st Qu.:13.01   1st Qu.:21.08
##  Median :0.018730   Median :0.0031870   Median :14.97   Median :25.41
##  Mean   :0.020542   Mean   :0.0037949   Mean   :16.27   Mean   :25.68
##  3rd Qu.:0.023480   3rd Qu.:0.0045580   3rd Qu.:18.79   3rd Qu.:29.72
##  Max.   :0.078950   Max.   :0.0298400   Max.   :36.04   Max.   :49.54
##  perimeter_worst     area_worst      smoothness_worst  compactness_worst
##  Min.   : 50.41   Min.   : 185.2   Min.   :0.07117   Min.   :0.02729
##  1st Qu.: 84.11   1st Qu.: 515.3   1st Qu.:0.11660   1st Qu.:0.14720
##  Median : 97.66   Median : 686.5   Median :0.13130   Median :0.21190
##  Mean   :107.26   Mean   : 880.6   Mean   :0.13237   Mean   :0.25427
##  3rd Qu.:125.40   3rd Qu.:1084.0   3rd Qu.:0.14600   3rd Qu.:0.33910
##  Max.   :251.20   Max.   :4254.0   Max.   :0.22260   Max.   :1.05800
##  concavity_worst  concave.points_worst symmetry_worst
fractal_dimension_worst
##  Min.   :0.0000   Min.   :0.00000    Min.   :0.1565   Min.   :0.05504
##  1st Qu.:0.1145   1st Qu.:0.06493    1st Qu.:0.2504   1st Qu.:0.07146
##  Median :0.2267   Median :0.09993    Median :0.2822   Median :0.08004
##  Mean   :0.2722   Mean   :0.11461    Mean   :0.2901   Mean   :0.08395
##  3rd Qu.:0.3829   3rd Qu.:0.16140    3rd Qu.:0.3179   3rd Qu.:0.09208
##  Max.   :1.2520   Max.   :0.29100    Max.   :0.6638   Max.   :0.20750
##     X
##  Mode:logical
##  NA's:569
##
##
##
##

#converting the categorical variable to factor
Cancer3$diagnosis = as.factor(Cancer3$diagnosis)
```

```
Cancer3Final = Cancer3[,c(-1,-13,-14,-15,-16,-17,-18,-19,-20,-21,-22,-23,-
24,-25,-26,-27,-28,-29,-30,-31,-32,-33,-34)] #remove id and X
summary(Cancer3Final)

##  diagnosis  radius_mean      texture_mean    perimeter_mean     area_mean
##  B:357      Min.   : 6.981   Min.   : 9.71   Min.   : 43.79   Min.   :
143.5
##  M:212      1st Qu.:11.700   1st Qu.:16.17   1st Qu.: 75.17   1st Qu.:
420.3
##             Median :13.370   Median :18.84   Median : 86.24   Median :
551.1
##             Mean   :14.127   Mean   :19.29   Mean   : 91.97   Mean   :
654.9
##             3rd Qu.:15.780   3rd Qu.:21.80   3rd Qu.:104.10   3rd Qu.:
782.7
##             Max.   :28.110   Max.   :39.28   Max.   :188.50   Max.
:2501.0
##  smoothness_mean    compactness_mean   concavity_mean    concave.points_mean
##  Min.   :0.05263    Min.   :0.01938    Min.   :0.00000   Min.   :0.00000
##  1st Qu.:0.08637    1st Qu.:0.06492    1st Qu.:0.02956   1st Qu.:0.02031
##  Median :0.09587    Median :0.09263    Median :0.06154   Median :0.03350
##  Mean   :0.09636    Mean   :0.10434    Mean   :0.08880   Mean   :0.04892
##  3rd Qu.:0.10530    3rd Qu.:0.13040    3rd Qu.:0.13070   3rd Qu.:0.07400
##  Max.   :0.16340    Max.   :0.34540    Max.   :0.42680   Max.   :0.20120
##  symmetry_mean     fractal_dimension_mean
##  Min.   :0.1060    Min.   :0.04996
##  1st Qu.:0.1619    1st Qu.:0.05770
##  Median :0.1792    Median :0.06154
##  Mean   :0.1812    Mean   :0.06280
##  3rd Qu.:0.1957    3rd Qu.:0.06612
##  Max.   :0.3040    Max.   :0.09744

Cancer3Final$diagnosis<- as.numeric(Cancer3Final$diagnosis)
Cancer3Final$diagnosis[1:569] <- Cancer3Final$diagnosis[1:569] - 1
Cancer3Final$diagnosis

##   [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1
##  [38] 0 1 1 1 1 1 1 1 1 0 1 0 0 0 0 0 1 1 0 1 1 0 0 0 0 1 0 1 1 0 0 0 0 1
0 1 1
##  [75] 0 1 0 1 1 0 0 0 1 1 0 1 1 1 0 0 0 1 0 0 1 1 0 0 0 1 1 0 0 0 0 1 0 0
1 0 0
## [112] 0 0 0 0 0 0 1 1 1 0 1 1 0 0 0 1 1 0 1 0 1 1 0 1 1 0 0 1 0 0 1 0 0 0
0 1 0
## [149] 0 0 0 0 0 0 0 0 1 0 0 0 0 1 1 0 1 0 0 1 1 0 0 1 1 0 0 0 0 1 0 0 1 1
1 0 1
## [186] 0 1 0 0 0 1 0 0 1 1 0 1 1 1 1 0 1 1 1 0 1 0 1 0 1 0 0 1 0 1 1 1 1 0 0 1
1 0 0
## [223] 0 1 0 0 0 0 0 1 1 0 0 1 0 0 1 1 0 1 0 0 0 0 1 0 0 0 0 0 1 0 1 1 1 1
```

```
1 1 1
## [260] 1 1 1 1 1 1 1 0 0 0 0 0 0 0 1 0 1 0 0 1 0 0 1 0 1 1 0 0 0 0 0 0 0 0 0
0 0 0
## [297] 0 1 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 1
1 0 0
## [334] 0 0 1 0 1 0 1 0 0 0 1 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1
0 1 1
## [371] 1 0 1 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 1 0 0 0 0 0 0 1 0 0 0
0 0 0
## [408] 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 0 1 0 0 0 0 0 0
1 0 0
## [445] 1 0 1 0 0 1 0 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0
## [482] 0 0 0 0 0 0 1 0 1 0 0 1 0 0 0 0 0 1 1 0 1 0 1 0 0 0 0 0 1 0 0 1 0 1
0 1 1
## [519] 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
## [556] 0 0 0 0 0 0 0 1 1 1 1 1 1 0
```

##split the data set into training and eval
```
s = sample(399,170)
eval= Cancer3Final[s,]  # eval with 60%
train= Cancer3Final[-s,] # train with 40%
```

regression on train set
```
res = glm(diagnosis~.,family=binomial,data=train)
```

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

```
summary(res)
```

```
##
## Call:
## glm(formula = diagnosis ~ ., family = binomial, data = train)
##
## Deviance Residuals:
##      Min         1Q     Median         3Q        Max
## -1.75729   -0.10560   -0.02162    0.00343    2.87650
##
## Coefficients:
##                        Estimate Std. Error z value  Pr(>|z|)
## (Intercept)            -19.48319   20.40369  -0.955    0.3396
## radius_mean              2.00643    4.89863   0.410    0.6821
## texture_mean             0.41013    0.09039   4.537 0.0000057 ***
## perimeter_mean          -0.51230    0.66627  -0.769    0.4419
## area_mean                0.02731    0.02400   1.138    0.2552
## smoothness_mean         58.10482   43.87817   1.324    0.1854
## compactness_mean         8.17211   31.21603   0.262    0.7935
## concavity_mean           6.35997   10.95567   0.581    0.5616
## concave.points_mean     96.60006   42.36349   2.280    0.0226 *
## symmetry_mean           30.10462   14.05010   2.143    0.0321 *
```

```
## fractal_dimension_mean -80.03733  122.29429  -0.654     0.5128
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 521.841  on 398  degrees of freedom
## Residual deviance:  85.751  on 388  degrees of freedom
## AIC: 107.75
##
## Number of Fisher Scoring iterations: 9

drop1(res)

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

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

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

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

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

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

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

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

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

## Single term deletions
##
## Model:
## diagnosis ~ radius_mean + texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##     symmetry_mean + fractal_dimension_mean
##                      Df Deviance    AIC
## <none>                   85.751 107.75
## radius_mean           1   85.917 105.92
## texture_mean          1  116.902 136.90
## perimeter_mean        1   86.349 106.35
## area_mean             1   86.994 106.99
## smoothness_mean       1   87.579 107.58
## compactness_mean      1   85.820 105.82
## concavity_mean        1   86.091 106.09
## concave.points_mean   1   91.722 111.72
```

```
## symmetry_mean             1   90.561 110.56
## fractal_dimension_mean  1   86.185 106.19

reg1 = glm(diagnosis~.-compactness_mean, family = binomial, data=train)

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

drop1(reg1)

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

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

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

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

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

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

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

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

## Single term deletions
##
## Model:
## diagnosis ~ (radius_mean + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean) - compactness_mean
##                        Df Deviance    AIC
## <none>                      85.820 105.82
## radius_mean              1   85.920 103.92
## texture_mean             1  117.146 135.15
## perimeter_mean           1   86.607 104.61
## area_mean                1   86.999 105.00
## smoothness_mean          1   87.685 105.69
## concavity_mean           1   86.133 104.13
## concave.points_mean      1   91.853 109.85
## symmetry_mean            1   91.040 109.04
## fractal_dimension_mean   1   86.248 104.25

reg2 = glm(diagnosis~.-radius_mean-compactness_mean, family = binomial,
data=train)

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

drop1(reg2)
```

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

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

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

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

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

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

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

## Single term deletions
##
## Model:
## diagnosis ~ (radius_mean + texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##     symmetry_mean + fractal_dimension_mean) - radius_mean -
compactness_mean
##                       Df Deviance    AIC
## <none>                    85.920 103.92
## texture_mean           1  117.450 133.45
## perimeter_mean         1   87.636 103.64
## area_mean              1   90.346 106.35
## smoothness_mean        1   88.063 104.06
## concavity_mean         1   86.169 102.17
## concave.points_mean    1   91.865 107.86
## symmetry_mean          1   91.055 107.06
## fractal_dimension_mean 1   86.808 102.81

reg3 = glm(diagnosis~.-radius_mean-compactness_mean-concavity_mean, family =
binomial, data=train)

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

drop1(reg3)

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

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

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

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

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

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

## Single term deletions
##
## Model:
## diagnosis ~ (radius_mean + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean) - radius_mean -
compactness_mean -
##      concavity_mean
##                        Df Deviance    AIC
## <none>                      86.169 102.17
## texture_mean            1  117.773 131.77
## perimeter_mean          1   88.524 102.52
## area_mean               1   91.200 105.20
## smoothness_mean         1   88.430 102.43
## concave.points_mean     1  105.009 119.01
## symmetry_mean           1   92.404 106.40
## fractal_dimension_mean  1   86.809 100.81

eval$Prediction=predict(reg3,eval,type="response")
eval[1:20,]

##      diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 324          1       20.34        21.51         135.90    1264.0
0.11700
## 167          0       10.80         9.71          68.77     357.6
0.09594
## 129          0       15.10        16.39          99.58     674.5
0.11500
## 299          0       14.26        18.17          91.22     633.1
0.06576
## 270          0       10.71        20.39          69.50     344.9
0.10820
## 187          1       18.31        18.58         118.60    1041.0
0.08588
## 307          0       13.20        15.82          84.07     537.3
0.08511
## 85           0       12.00        15.65          76.95     443.3
0.09723
## 277          0       11.33        14.16          71.79     396.6
0.09379
## 362          0       13.30        21.57          85.24     546.1
0.08582
## 330          1       16.26        21.88         107.50     826.8
0.11650
## 263          1       17.29        22.13         114.40     947.8
```

```
0.08999
## 329          1      16.27       20.71       106.90    813.7
0.11690
## 79           1      20.18       23.97       143.70    1245.0
0.12860
## 213          1      28.11       18.47       188.50    2499.0
0.11420
## 37           1      14.25       21.72        93.63    633.0
0.09823
## 105          0      10.49       19.29        67.41    336.1
0.09989
## 217          0      11.89       18.35        77.32    432.2
0.09363
## 366          1      20.44       21.78       133.80    1293.0
0.09150
## 165          1      23.27       22.04       152.10    1686.0
0.08439
##      compactness_mean concavity_mean concave.points_mean symmetry_mean
## 324          0.18750       0.256500            0.150400        0.2569
## 167          0.05736       0.025310            0.016980        0.1381
## 129          0.18070       0.113800            0.085340        0.2001
## 299          0.05220       0.024750            0.013740        0.1635
## 270          0.12890       0.084480            0.028670        0.1668
## 187          0.08468       0.081690            0.058140        0.1621
## 307          0.05251       0.001461            0.003261        0.1632
## 85           0.07165       0.041510            0.018630        0.2079
## 277          0.03872       0.001487            0.003333        0.1954
## 362          0.06373       0.033440            0.024240        0.1815
## 330          0.12830       0.179900            0.079810        0.1869
## 263          0.12730       0.096970            0.075070        0.2108
## 329          0.13190       0.147800            0.084880        0.1948
## 79           0.34540       0.375400            0.160400        0.2906
## 213          0.15160       0.320100            0.159500        0.1648
## 37           0.10980       0.131900            0.055980        0.1885
## 105          0.08578       0.029950            0.012010        0.2217
## 217          0.11540       0.066360            0.031420        0.1967
## 366          0.11310       0.097990            0.077850        0.1618
## 165          0.11450       0.132400            0.097020        0.1801
##      fractal_dimension_mean       Prediction
## 324                 0.06670 0.999999999890
## 167                 0.06400 0.000005663968
## 129                 0.06467 0.935054132705
## 299                 0.05586 0.001388255956
## 270                 0.06862 0.002878512903
## 187                 0.05425 0.994464307003
## 307                 0.05894 0.000116760336
## 85                  0.05968 0.001498298902
## 277                 0.05821 0.000087465360
## 362                 0.05696 0.023578625180
## 330                 0.06532 0.998740498905
```

```
## 263              0.05464 0.999762823565
## 329              0.06277 0.999002574889
## 79               0.08142 0.999999999893
## 213              0.05525 1.000000000000
## 37               0.06125 0.713860607256
## 105              0.06481 0.001905054820
## 217              0.06314 0.005573390666
## 366              0.05557 0.999997428743
## 165              0.05553 0.999999999916
```

```
hist(eval$Prediction)
```


Histogram of eval$Prediction
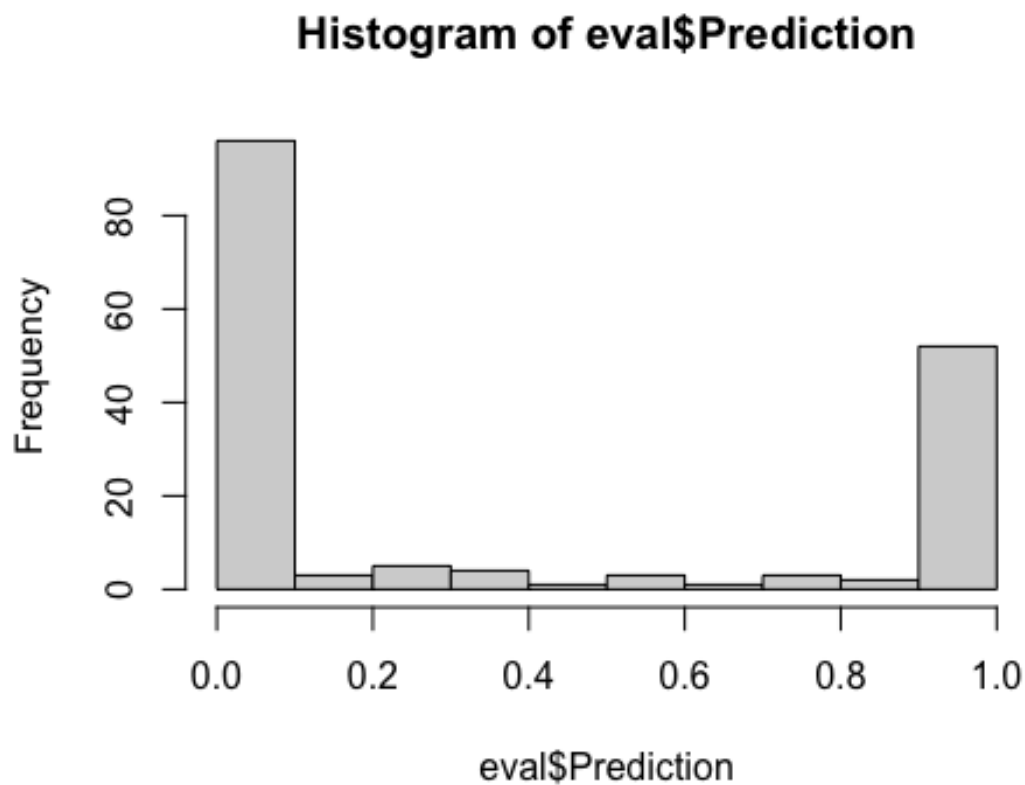
```
plot(eval$diagnosis~eval$Prediction)
```

```r
#get fasle positive and false negative
# Calculation of KPI's
eval$falsePositive = ifelse(eval$Prediction>=0.5 & eval$diagnosis == 0, 1, 0)
eval$falseNegative = ifelse(eval$Prediction<0.5 & eval$diagnosis == 1, 1, 0)

eval$falsePositive
```

```
##   [1] 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
##  [38] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
##  [75] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
## [112] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
## [149] 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
```

```r
eval$falseNegative
```

```
##   [1] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
1 1 0
##  [38] 0 0 0 1 0 0 0 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
##  [75] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

```
0 0 0
## [112] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
## [149] 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
```

```
# Where was the model wrong?

eval[1:20,]
```

```
##      diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 324         1       20.34        21.51         135.90    1264.0
0.11700
## 167         0       10.80         9.71          68.77     357.6
0.09594
## 129         0       15.10        16.39          99.58     674.5
0.11500
## 299         0       14.26        18.17          91.22     633.1
0.06576
## 270         0       10.71        20.39          69.50     344.9
0.10820
## 187         1       18.31        18.58         118.60    1041.0
0.08588
## 307         0       13.20        15.82          84.07     537.3
0.08511
## 85          0       12.00        15.65          76.95     443.3
0.09723
## 277         0       11.33        14.16          71.79     396.6
0.09379
## 362         0       13.30        21.57          85.24     546.1
0.08582
## 330         1       16.26        21.88         107.50     826.8
0.11650
## 263         1       17.29        22.13         114.40     947.8
0.08999
## 329         1       16.27        20.71         106.90     813.7
0.11690
## 79          1       20.18        23.97         143.70    1245.0
0.12860
## 213         1       28.11        18.47         188.50    2499.0
0.11420
## 37          1       14.25        21.72          93.63     633.0
0.09823
## 105         0       10.49        19.29          67.41     336.1
0.09989
## 217         0       11.89        18.35          77.32     432.2
0.09363
## 366         1       20.44        21.78         133.80    1293.0
0.09150
## 165         1       23.27        22.04         152.10    1686.0
```

```
0.08439
##      compactness_mean concavity_mean concave.points_mean symmetry_mean
## 324          0.18750       0.256500            0.150400        0.2569
## 167          0.05736       0.025310            0.016980        0.1381
## 129          0.18070       0.113800            0.085340        0.2001
## 299          0.05220       0.024750            0.013740        0.1635
## 270          0.12890       0.084480            0.028670        0.1668
## 187          0.08468       0.081690            0.058140        0.1621
## 307          0.05251       0.001461            0.003261        0.1632
## 85           0.07165       0.041510            0.018630        0.2079
## 277          0.03872       0.001487            0.003333        0.1954
## 362          0.06373       0.033440            0.024240        0.1815
## 330          0.12830       0.179900            0.079810        0.1869
## 263          0.12730       0.096970            0.075070        0.2108
## 329          0.13190       0.147800            0.084880        0.1948
## 79           0.34540       0.375400            0.160400        0.2906
## 213          0.15160       0.320100            0.159500        0.1648
## 37           0.10980       0.131900            0.055980        0.1885
## 105          0.08578       0.029950            0.012010        0.2217
## 217          0.11540       0.066360            0.031420        0.1967
## 366          0.11310       0.097990            0.077850        0.1618
## 165          0.11450       0.132400            0.097020        0.1801
##      fractal_dimension_mean      Prediction falsePositive falseNegative
## 324                0.06670 0.999999999890             0             0
## 167                0.06400 0.000005663968             0             0
## 129                0.06467 0.935054132705             1             0
## 299                0.05586 0.001388255956             0             0
## 270                0.06862 0.002878512903             0             0
## 187                0.05425 0.994464307003             0             0
## 307                0.05894 0.000116760336             0             0
## 85                 0.05968 0.001498298902             0             0
## 277                0.05821 0.000087465360             0             0
## 362                0.05696 0.023578625180             0             0
## 330                0.06532 0.998740498905             0             0
## 263                0.05464 0.999762823565             0             0
## 329                0.06277 0.999002574889             0             0
## 79                 0.08142 0.999999999893             0             0
## 213                0.05525 1.000000000000             0             0
## 37                 0.06125 0.713860607256             0             0
## 105                0.06481 0.001905054820             0             0
## 217                0.06314 0.005573390666             0             0
## 366                0.05557 0.999997428743             0             0
## 165                0.05553 0.999999999916             0             0

# Here we FILTER false positives and negatives from the data
falsePositive = eval[eval$falsePositive==1,]
falseNegative = eval[eval$falseNegative==1,]
falsePositive # This displays it on screen
```

```
##     diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 129         0       15.10        16.39          99.58     674.5
0.1150
## 276         0       11.89        17.36          76.20     435.6
0.1225
##     compactness_mean concavity_mean concave.points_mean symmetry_mean
## 129           0.1807        0.11380             0.08534        0.2001
## 276           0.0721        0.05929             0.07404        0.2015
##     fractal_dimension_mean Prediction falsePositive falseNegative
## 129                0.06467  0.9350541             1             0
## 276                0.05875  0.7974453             1             0
```

falseNegative

```
##     diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 42          1       10.95        21.35          71.90     371.1
0.12270
## 40          1       13.48        20.82          88.40     559.2
0.10160
## 172         1       13.43        19.63          85.84     565.4
0.09048
## 298         1       11.76        18.14          75.00     431.1
0.09968
## 45          1       13.17        21.81          85.42     531.5
0.09714
## 206         1       15.12        16.68          98.78     716.6
0.08876
## 380         1       11.08        18.83          73.30     361.6
0.12160
## 127         1       13.61        24.69          87.76     572.6
0.09258
## 41          1       13.44        21.58          86.18     563.0
0.08162
##     compactness_mean concavity_mean concave.points_mean symmetry_mean
## 42           0.12180        0.10440             0.05669        0.1895
## 40           0.12550        0.10630             0.05439        0.1720
## 172          0.06288        0.05858             0.03438        0.1598
## 298          0.05914        0.02685             0.03515        0.1619
## 45           0.10470        0.08259             0.05252        0.1746
## 206          0.09588        0.07550             0.04079        0.1594
## 380          0.21540        0.16890             0.06367        0.2196
## 127          0.07862        0.05285             0.03085        0.1761
## 41           0.06031        0.03110             0.02031        0.1784
##     fractal_dimension_mean  Prediction falsePositive falseNegative
## 42                 0.06870 0.320989574             0             1
## 40                 0.06419 0.251576794             0             1
## 172                0.05671 0.033414894             0             1
## 298                0.06287 0.006573481             0             1
```

```
## 45                    0.06177 0.277845095              0                    1
## 206                   0.05986 0.055791303              0                    1
## 380                   0.07950 0.202029928              0                    1
## 127                   0.06130 0.160224232              0                    1
## 41                    0.05587 0.016167469              0                    1
```

```
error = (nrow(falseNegative) + nrow(falsePositive))/nrow(eval)
error
```

```
## [1] 0.06470588
```

Our model got ~ 6.47% of the predictions wrong.

PLOT THE LIFT CURVE
```
eval[1:3,]
```

```
##     diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 324         1       20.34        21.51         135.90    1264.0
0.11700
## 167         0       10.80         9.71          68.77     357.6
0.09594
## 129         0       15.10        16.39          99.58     674.5
0.11500
##     compactness_mean concavity_mean concave.points_mean symmetry_mean
## 324          0.18750        0.25650             0.15040        0.2569
## 167          0.05736        0.02531             0.01698        0.1381
## 129          0.18070        0.11380             0.08534        0.2001
##     fractal_dimension_mean      Prediction falsePositive falseNegative
## 324                0.06670 0.999999999890             0             0
## 167                0.06400 0.000005663968             0             0
## 129                0.06467 0.935054132705             1             0
```

```
evalOrdered = eval[order(eval$Prediction, decreasing = TRUE),]
evalOrdered[1:3,]
```

```
##     diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 213         1       28.11        18.47          188.5      2499
0.1142
## 340         1       23.51        24.27          155.1      1747
0.1069
## 181         1       27.22        21.87          182.1      2250
0.1094
##     compactness_mean concavity_mean concave.points_mean symmetry_mean
## 213           0.1516         0.3201              0.1595        0.1648
## 340           0.1283         0.2308              0.1410        0.1797
## 181           0.1914         0.2871              0.1878        0.1800
##     fractal_dimension_mean Prediction falsePositive falseNegative
## 213                0.05525          1             0             0
```

```
## 340                  0.05506         1          0          0
## 181                  0.05770         1          0          0
```

```r
# dummy variables
xaxis = NULL
cumMean = NULL # cumulative mean
cumLift = NULL # cumulative lift
meanResponse = mean(eval$diagnosis) # mean curve
meanResponse # Our model predicts the results better than just guessing by
~37%
```

```
## [1] 0.4
```

```r
# initiate variables
xaxis[1] = 1
cumMean[1] = meanResponse
cumLift[1] = evalOrdered$diagnosis[1] # We are most interested in the case
where we assume we are right
# repeat for all rows
for (i in 2:nrow(evalOrdered)){
  xaxis[i] = i
  cumMean[i] = cumMean[i-1]+meanResponse
  cumLift[i] = cumLift[i-1]+evalOrdered$diagnosis[i]
}
# At this point we need to check the cumulative lift in the values section.
In the beginning it goes up by 1, this is good sign.
plot(cumMean~xaxis) # plots the mean line
points(cumLift~xaxis) # plots the lift curve
```
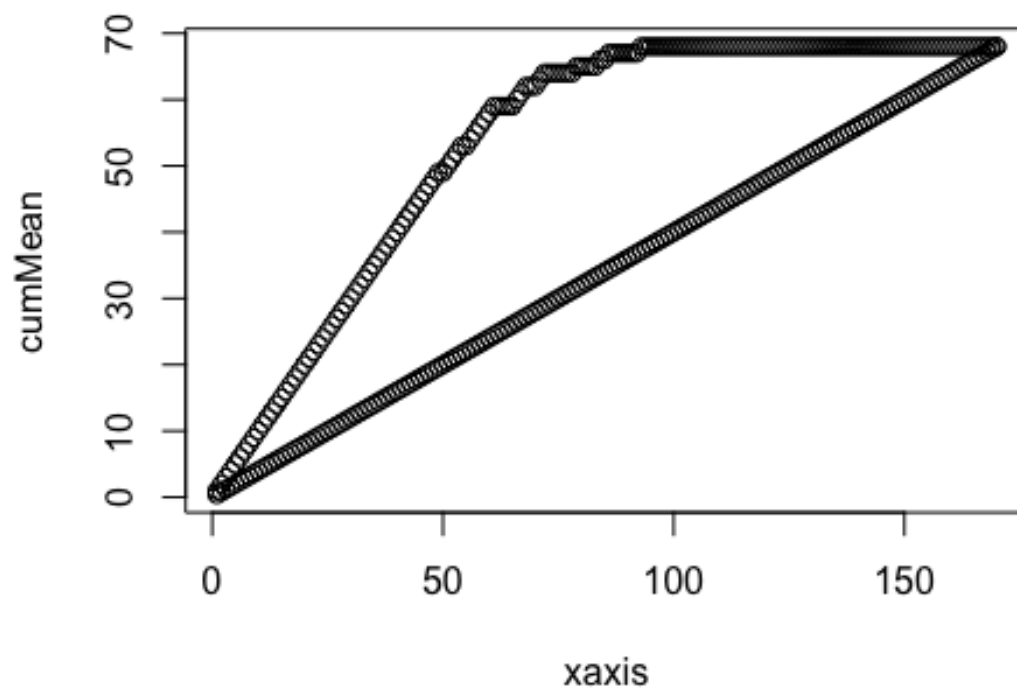
```
## HERE WE PLOT THE ROC CURVE ##
library(ROCR)
prediction2 = prediction(eval$Prediction, eval$diagnosis)
roc = performance(prediction2, "sens", "fpr")
plot(roc) #this checks for different cutt off points
```

```
# cross-validation (leave one out) with the full model
CV = length(Cancer3Final$diagnosis)
for (k in 1:569) {
  Cancer_evaluation_cv = Cancer3Final[k, ]
  Cancer_training_cv = Cancer3Final[-k, ]
  model_CV = glm(diagnosis~ ., data = Cancer_training_cv, family = binomial)
  CV[k] = predict(model_CV, Cancer_evaluation_cv, type="response")
}

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```r
Cancer3Final$CV_prediction = CV

# repeating previous steps
## false positive, false negatives, misdiagnosisification rate
false_positive_cv=Cancer3Final[Cancer3Final$CV_prediction >= 0.5 &
Cancer3Final$diagnosis==0,]
false_positive_cv
```

```
##      diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 90          0      14.640        15.24          95.77     651.9
0.11320
## 113         0      14.260        19.65          97.83     629.9
0.07837
## 129         0      15.100        16.39          99.58     674.5
0.11500
## 153         0       9.731        15.34          63.78     300.2
0.10720
## 158         0      16.840        19.46         108.40     880.2
0.07445
## 239         0      14.220        27.85          92.55     623.9
0.08223
## 276         0      11.890        17.36          76.20     435.6
0.12250
## 364         0      16.500        18.29         106.60     838.1
0.09686
## 456         0      13.380        30.72          86.34     557.2
0.09245
## 492         0      17.850        13.23         114.60     992.1
```

```
0.07838
## 509            0       16.300          15.70           104.70       819.8
0.09427
## 529            0       13.940          13.17            90.31       594.2
0.12480
## 538            0       11.690          24.44            76.37       406.4
0.12360
## 542            0       14.470          24.99            95.81       656.4
0.08837
## 561            0       14.050          27.15            91.38       600.4
0.09929
##      compactness_mean concavity_mean concave.points_mean symmetry_mean
## 90            0.13390        0.09966             0.07064        0.2116
## 113           0.22330        0.30030             0.07798        0.1704
## 129           0.18070        0.11380             0.08534        0.2001
## 153           0.15990        0.41080             0.07857        0.2548
## 158           0.07223        0.05150             0.02771        0.1844
## 239           0.10390        0.11030             0.04408        0.1342
## 276           0.07210        0.05929             0.07404        0.2015
## 364           0.08468        0.05862             0.04835        0.1495
## 456           0.07426        0.02819             0.03264        0.1375
## 492           0.06217        0.04445             0.04178        0.1220
## 509           0.06712        0.05526             0.04563        0.1711
## 529           0.09755        0.10100             0.06615        0.1976
## 538           0.15520        0.04515             0.04531        0.2131
## 542           0.12300        0.10090             0.03890        0.1872
## 561           0.11260        0.04462             0.04304        0.1537
##      fractal_dimension_mean CV_prediction
## 90                  0.06346     0.7098976
## 113                 0.07769     0.7472802
## 129                 0.06467     0.9241708
## 153                 0.09296     0.9860191
## 158                 0.05268     0.6277209
## 239                 0.06129     0.6720621
## 276                 0.05875     0.8428632
## 364                 0.05593     0.8149527
## 456                 0.06016     0.7077005
## 492                 0.05243     0.6833568
## 509                 0.05657     0.5281348
## 529                 0.06457     0.5213198
## 538                 0.07405     0.5353958
## 542                 0.06341     0.7446412
## 561                 0.06171     0.6985200

nrow(false_positive_cv)

## [1] 15
```

```
false_negative_cv=Cancer3Final[Cancer3Final$CV_prediction < 0.5 &
Cancer3Final$diagnosis==1,]
false_negative_cv
```

```
##      diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 32          1       11.84        18.70          77.93     440.6
0.11090
## 40          1       13.48        20.82          88.40     559.2
0.10160
## 41          1       13.44        21.58          86.18     563.0
0.08162
## 42          1       10.95        21.35          71.90     371.1
0.12270
## 44          1       13.28        20.28          87.32     545.2
0.10410
## 45          1       13.17        21.81          85.42     531.5
0.09714
## 55          1       15.10        22.02          97.26     712.8
0.09056
## 74          1       13.80        15.79          90.43     584.1
0.10070
## 127         1       13.61        24.69          87.76     572.6
0.09258
## 136         1       12.77        22.47          81.72     506.3
0.09055
## 147         1       11.80        16.58          78.99     432.0
0.10910
## 172         1       13.43        19.63          85.84     565.4
0.09048
## 185         1       15.28        22.41          98.92     710.6
0.09057
## 206         1       15.12        16.68          98.78     716.6
0.08876
## 216         1       13.86        16.93          90.96     578.9
0.10260
## 256         1       13.96        17.05          91.43     602.4
0.10960
## 264         1       15.61        19.38         100.00     758.6
0.07840
## 298         1       11.76        18.14          75.00     431.1
0.09968
## 380         1       11.08        18.83          73.30     361.6
0.12160
## 490         1       16.69        20.20         107.10     857.6
0.07497
## 515         1       15.05        19.07          97.26     701.9
0.09215
##      compactness_mean concavity_mean concave.points_mean symmetry_mean
## 32            0.15160        0.12180             0.05182        0.2301
```

```
## 40             0.12550        0.10630         0.05439        0.1720
## 41             0.06031        0.03110         0.02031        0.1784
## 42             0.12180        0.10440         0.05669        0.1895
## 44             0.14360        0.09847         0.06158        0.1974
## 45             0.10470        0.08259         0.05252        0.1746
## 55             0.07081        0.05253         0.03334        0.1616
## 74             0.12800        0.07789         0.05069        0.1662
## 127            0.07862        0.05285         0.03085        0.1761
## 136            0.05761        0.04711         0.02704        0.1585
## 147            0.17000        0.16590         0.07415        0.2678
## 172            0.06288        0.05858         0.03438        0.1598
## 185            0.10520        0.05375         0.03263        0.1727
## 206            0.09588        0.07550         0.04079        0.1594
## 216            0.15170        0.09901         0.05602        0.2106
## 256            0.12790        0.09789         0.05246        0.1908
## 264            0.05616        0.04209         0.02847        0.1547
## 298            0.05914        0.02685         0.03515        0.1619
## 380            0.21540        0.16890         0.06367        0.2196
## 490            0.07112        0.03649         0.02307        0.1846
## 515            0.08597        0.07486         0.04335        0.1561
##      fractal_dimension_mean CV_prediction
## 32                  0.07799   0.161266765
## 40                  0.06419   0.354805225
## 41                  0.05587   0.022660394
## 42                  0.06870   0.497252979
## 44                  0.06782   0.468854531
## 45                  0.06177   0.280729964
## 55                  0.05684   0.433122073
## 74                  0.06566   0.036142521
## 127                 0.06130   0.226344915
## 136                 0.06065   0.033237848
## 147                 0.07371   0.426616845
## 172                 0.05671   0.054728837
## 185                 0.06317   0.230289830
## 206                 0.05986   0.094737899
## 216                 0.06916   0.109618230
## 256                 0.06130   0.318913742
## 264                 0.05443   0.109278719
## 298                 0.06287   0.008123391
## 380                 0.07950   0.134260079
## 490                 0.05325   0.297966490
## 515                 0.05915   0.261394798

nrow(false_negative_cv)

## [1] 21

error_cv = (nrow(false_negative_cv) +
nrow(false_positive_cv))/nrow(Cancer3Final)
error_cv
```

```
## [1] 0.06326889
```

```
evalOrderedCV = Cancer3Final[order(Cancer3Final$CV_prediction, decreasing =
TRUE),]
evalOrderedCV
```

```
##      diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 83          1      25.220        24.91         171.50    1878.0
0.10630
## 123         1      24.250        20.20         166.20    1761.0
0.14470
## 181         1      27.220        21.87         182.10    2250.0
0.10940
## 203         1      23.290        26.67         158.90    1685.0
0.11410
## 213         1      28.110        18.47         188.50    2499.0
0.11420
## 340         1      23.510        24.27         155.10    1747.0
0.10690
## 353         1      25.730        17.46         174.20    2010.0
0.11490
## 462         1      27.420        26.27         186.90    2501.0
0.10840
## 522         1      24.630        21.60         165.50    1841.0
0.10300
## 109         1      22.270        19.67         152.80    1509.0
0.13260
## 237         1      23.210        26.97         153.50    1670.0
0.09509
## 565         1      21.560        22.39         142.00    1479.0
0.11100
## 370         1      22.010        21.90         147.20    1482.0
0.10630
## 394         1      21.610        22.28         144.40    1407.0
0.11670
## 568         1      20.600        29.33         140.10    1265.0
0.11780
## 504         1      23.090        19.83         152.10    1682.0
0.09342
## 165         1      23.270        22.04         152.10    1686.0
0.08439
## 564         1      20.920        25.09         143.00    1347.0
0.10990
## 79          1      20.180        23.97         143.70    1245.0
0.12860
## 266         1      20.730        31.12         135.70    1419.0
0.09469
## 251         1      20.940        23.56         138.90    1364.0
```

```
0.10070
## 182          1     21.090      26.57       142.70      1311.0
0.11410
## 324          1     20.340      21.51       135.90      1264.0
0.11700
## 273          1     21.750      20.99       147.30      1491.0
0.09401
## 369          1     21.710      17.25       140.90      1546.0
0.09384
## 536          1     20.550      20.86       137.80      1308.0
0.10460
## 303          1     20.090      23.86       134.70      1247.0
0.10800
## 84           1     19.100      26.29       129.10      1132.0
0.12150
## 500          1     20.590      21.24       137.80      1320.0
0.10850
## 450          1     21.100      20.52       138.10      1384.0
0.09684
## 261          1     20.310      27.06       132.90      1288.0
0.10000
## 24           1     21.160      23.04       137.20      1404.0
0.09428
## 367          1     20.200      26.83       133.70      1234.0
0.09905
## 566          1     20.130      28.25       131.20      1261.0
0.09780
## 257          1     19.550      28.77       133.60      1207.0
0.09260
## 3            1     19.690      21.25       130.00      1203.0
0.10960
## 130          1     19.790      25.12       130.40      1192.0
0.10150
## 163          1     19.590      18.15       130.70      1214.0
0.11200
## 234          1     20.510      27.81       134.40      1319.0
0.09159
## 433          1     20.180      19.54       133.80      1250.0
0.11330
## 373          1     21.370      15.10       141.30      1386.0
0.10010
## 31           1     18.630      25.11       124.80      1088.0
0.10640
## 534          1     20.470      20.67       134.70      1299.0
0.09156
## 19           1     19.810      22.15       130.00      1260.0
0.09831
## 301          1     19.530      18.90       129.50      1217.0
0.11500
## 220          1     19.530      32.47       128.00      1223.0
```

```
0.08420
## 211         1     20.580     22.14       134.70     1290.0
0.09090
## 344         1     19.680     21.68       129.90     1194.0
0.09797
## 452         1     19.590     25.00       127.70     1191.0
0.10320
## 281         1     19.160     26.60       126.20     1138.0
0.10200
## 96          1     20.260     23.03       132.40     1264.0
0.09078
## 390         1     19.550     23.21       128.90     1174.0
0.10100
## 488         1     19.440     18.82       128.10     1167.0
0.10890
## 240         1     17.460     39.28       113.40      920.6
0.09812
## 374         1     20.640     17.35       134.80     1335.0
0.09446
## 5           1     20.290     14.34       135.10     1297.0
0.10030
## 219         1     19.800     21.56       129.70     1230.0
0.09383
## 253         1     19.730     19.82       130.70     1206.0
0.10620
## 245         1     19.400     23.50       129.10     1155.0
0.10270
## 33          1     17.020     23.98       112.80      899.3
0.11970
## 13          1     19.170     24.80       132.40     1123.0
0.09740
## 401         1     17.910     21.02       124.40      994.0
0.12300
## 366         1     20.440     21.78       133.80     1293.0
0.09150
## 518         1     19.890     20.26       130.50     1214.0
0.10370
## 34          1     19.270     26.47       127.90     1162.0
0.09401
## 43          1     19.070     24.81       128.30     1104.0
0.09081
## 322         1     20.160     19.66       131.10     1274.0
0.08020
## 169         1     17.470     24.68       116.10      984.6
0.10490
## 26          1     17.140     16.40       116.00      912.7
0.11860
## 434         1     18.820     21.97       123.70     1110.0
0.10180
## 2           1     20.570     17.77       132.90     1326.0
```

```
0.08474
## 255          1      19.450      19.33      126.50     1169.0
0.10350
## 238          1      20.480      21.46      132.50     1306.0
0.08355
## 57           1      19.210      18.57      125.50     1152.0
0.10530
## 54           1      18.220      18.70      120.30     1033.0
0.11480
## 447          1      17.750      28.03      117.30      981.6
0.09997
## 517          1      18.310      20.58      120.80     1052.0
0.10680
## 283          1      19.400      18.18      127.20     1145.0
0.10370
## 259          1      15.660      23.20      110.20      773.5
0.11090
## 46           1      18.650      17.60      123.70     1076.0
0.10990
## 1            1      17.990      10.38      122.80     1001.0
0.11840
## 157          1      17.680      20.74      117.40      963.7
0.11150
## 88           1      19.020      24.59      122.00     1076.0
0.09029
## 71           1      18.940      21.31      123.60     1130.0
0.09009
## 86           1      18.460      18.52      121.10     1075.0
0.09874
## 260          1      15.530      33.56      103.70      744.9
0.10630
## 162          1      19.190      15.94      126.30     1157.0
0.08694
## 25           1      16.650      21.38      110.00      904.6
0.11210
## 28           1      18.610      20.25      122.10     1094.0
0.09440
## 199          1      19.180      22.49      127.50     1148.0
0.08523
## 336          1      17.060      21.00      111.80      918.6
0.11190
## 563          1      15.220      30.62      103.40      716.9
0.10480
## 469          1      17.600      23.33      119.00      980.5
0.09289
## 231          1      17.050      19.08      113.40      895.0
0.11410
## 122          1      18.660      17.12      121.40     1077.0
0.10540
## 73           1      17.200      24.52      114.20      929.4
```

```
0.10710
## 135           1      18.450       21.91       120.20      1075.0
0.09430
## 352           1      15.750       19.22       107.10       758.6
0.12430
## 78            1      18.050       16.15       120.20      1006.0
0.10650
## 499           1      18.490       17.52       121.30      1068.0
0.10120
## 409           1      17.990       20.66       117.80       991.7
0.10360
## 461           1      17.080       27.15       111.20       930.9
0.09898
## 493           1      18.010       20.56       118.40      1007.0
0.10010
## 128           1      19.000       18.91       123.40      1138.0
0.08217
## 258           1      15.320       17.27       103.20       713.3
0.13350
## 338           1      18.770       21.43       122.90      1092.0
0.09116
## 119           1      15.780       22.91       105.70       782.6
0.11550
## 214           1      17.420       25.56       114.50       948.0
0.10060
## 7             1      18.250       19.98       119.60      1040.0
0.09463
## 371           1      16.350       23.29       109.00       840.4
0.09742
## 418           1      15.500       21.08       102.90       803.1
0.11200
## 318           1      18.220       18.87       118.70      1027.0
0.09746
## 263           1      17.290       22.13       114.40       947.8
0.08999
## 278           1      18.810       19.98       120.90      1102.0
0.08923
## 330           1      16.260       21.88       107.50       826.8
0.11650
## 18            1      16.130       20.68       108.10       798.8
0.11700
## 29            1      15.300       25.27       102.40       732.4
0.10820
## 204           1      13.810       23.75        91.56       597.8
0.13230
## 329           1      16.270       20.71       106.90       813.7
0.11690
## 265           1      17.190       22.07       111.60       928.3
0.09726
## 16            1      14.540       27.54        96.73       658.8
```

```
0.11390
## 510          1      15.460      23.95      103.80      731.3
0.11830
## 480          1      16.250      19.51      109.80      815.8
0.10260
## 254          1      17.300      17.08      113.00      928.2
0.10080
## 275          1      17.930      24.48      115.20      998.9
0.08855
## 198          1      18.080      21.84      117.40     1024.0
0.07371
## 393          1      15.490      19.97      102.40      744.7
0.11600
## 442          1      17.270      25.42      112.40      928.8
0.08331
## 66           1      14.780      23.94       97.40      668.3
0.11720
## 431          1      14.900      22.53      102.10      685.0
0.09947
## 178          1      16.460      20.11      109.30      832.9
0.09831
## 567          1      16.600      28.08      108.30      858.1
0.08455
## 120          1      17.950      20.01      114.20      982.0
0.08402
## 187          1      18.310      18.58      118.60     1041.0
0.08588
## 202          1      17.540      19.32      115.10      951.6
0.08968
## 132          1      15.460      19.48      101.70      748.9
0.10920
## 284          1      16.240      18.77      108.80      805.1
0.10660
## 36           1      16.740      21.59      110.10      869.5
0.09610
## 9            1      13.000      21.82       87.50      519.8
0.12730
## 354          1      15.080      25.74       98.00      716.6
0.10240
## 30           1      17.570      15.05      115.00      955.1
0.09847
## 173          1      15.460      11.89      102.50      736.9
0.12570
## 153          0       9.731      15.34       63.78      300.2
0.10720
## 63           1      14.250      22.15       96.42      645.7
0.10490
## 208          1      17.010      20.26      109.70      904.3
0.08772
## 95           1      15.060      19.83      100.30      705.6
```

```
0.10390
## 133         1     16.160     21.54     106.20     809.8
0.10080
## 4           1     11.420     20.38      77.58     386.1
0.14250
## 168         1     16.780     18.80     109.30     886.3
0.08865
## 195         1     14.860     23.21     100.40     671.4
0.10440
## 502         1     13.820     24.49      92.33     595.9
0.11620
## 58          1     14.710     21.59      95.55     656.9
0.11370
## 35          1     16.130     17.88     107.00     807.2
0.10400
## 445         1     18.030     16.85     117.50     990.0
0.08947
## 76          1     16.070     19.65     104.10     817.7
0.09168
## 118         1     14.870     16.67      98.64     682.5
0.11620
## 139         1     14.950     17.57      96.85     678.1
0.11670
## 27          1     14.580     21.53      97.41     644.8
0.10540
## 10          1     12.460     24.04      83.97     475.9
0.11860
## 92          1     15.370     22.76     100.20     728.2
0.09200
## 14          1     15.850     23.95     103.70     782.7
0.08401
## 15          1     13.730     22.61      93.60     578.3
0.11310
## 106         1     13.110     15.56      87.21     530.2
0.13980
## 224         1     15.750     20.25     102.60     761.3
0.10250
## 23          1     15.340     14.26     102.50     704.4
0.10730
## 197         1     13.770     22.29      90.63     588.9
0.12000
## 415         1     15.130     29.81      96.71     719.5
0.08320
## 262         1     17.350     23.06     111.00     933.1
0.08662
## 537         1     14.270     22.55      93.77     629.8
0.10380
## 129         0     15.100     16.39      99.58     674.5
0.11500
## 191         1     14.220     23.12      94.37     609.9
```

```
0.10750
## 65          1     12.680     23.84       82.69      499.0
0.11220
## 513         1     13.400     20.52       88.64      556.7
0.11060
## 142         1     16.110     18.05      105.10      813.0
0.09721
## 12          1     15.780     17.89      103.60      781.0
0.09710
## 215         1     14.190     23.81       92.87      610.7
0.09463
## 276         0     11.890     17.36       76.20      435.6
0.12250
## 183         1     15.700     20.31      101.20      766.6
0.09597
## 364         0     16.500     18.29      106.60      838.1
0.09686
## 230         1     12.830     22.33       85.26      503.2
0.10880
## 48          1     13.170     18.66       85.98      534.6
0.11580
## 37          1     14.250     21.72       93.63      633.0
0.09823
## 331         1     16.030     15.51      105.80      793.2
0.09491
## 8           1     13.710     20.83       90.20      577.9
0.11890
## 113         0     14.260     19.65       97.83      629.9
0.07837
## 87          1     14.480     21.46       94.25      648.2
0.09444
## 542         0     14.470     24.99       95.81      656.4
0.08837
## 386         1     14.600     23.29       93.97      664.7
0.08682
## 194         1     12.340     26.86       81.15      477.4
0.10340
## 90          0     14.640     15.24       95.77      651.9
0.11320
## 456         0     13.380     30.72       86.34      557.2
0.09245
## 561         0     14.050     27.15       91.38      600.4
0.09929
## 17          1     14.680     20.13       94.74      684.5
0.09867
## 492         0     17.850     13.23      114.60      992.1
0.07838
## 239         0     14.220     27.85       92.55      623.9
0.08223
## 200         1     14.450     20.22       94.49      642.7
```

0.09872

## 101	1	13.610	24.98	88.05	582.7
					0.09488
## 6	1	12.450	15.70	82.57	477.1
					0.12780
## 158	0	16.840	19.46	108.40	880.2
					0.07445
## 39	1	14.990	25.20	95.54	698.8
					0.09387
## 11	1	16.020	23.24	102.70	797.8
					0.08206
## 436	1	13.980	19.62	91.12	599.5
					0.10600
## 538	0	11.690	24.44	76.37	406.4
					0.12360
## 509	0	16.300	15.70	104.70	819.8
					0.09427
## 100	1	14.420	19.77	94.48	642.5
					0.09752
## 529	0	13.940	13.17	90.31	594.2
					0.12480
## 42	1	10.950	21.35	71.90	371.1
					0.12270
## 376	0	16.170	16.07	106.30	788.5
					0.09880
## 291	0	14.410	19.73	96.03	651.0
					0.08757
## 44	1	13.280	20.28	87.32	545.2
					0.10410
## 543	0	14.740	25.42	94.70	668.6
					0.08275
## 496	0	14.870	20.21	96.12	680.9
					0.09587
## 414	0	14.990	22.11	97.53	693.7
					0.08515
## 55	1	15.100	22.02	97.26	712.8
					0.09056
## 147	1	11.800	16.58	78.99	432.0
					0.10910
## 151	0	13.000	20.78	83.51	519.4
					0.11350
## 134	0	15.710	13.93	102.00	761.7
					0.09462
## 544	0	13.210	28.06	84.88	538.4
					0.08671
## 40	1	13.480	20.82	88.40	559.2
					0.10160
## 77	0	13.530	10.94	87.91	559.2
					0.12910
## 292	0	14.960	19.10	97.03	687.3

						0.08992
## 91	0	14.620	24.02	94.57	662.7	0.08974
## 256	1	13.960	17.05	91.43	602.4	0.10960
## 397	0	13.510	18.89	88.10	558.1	0.10590
## 407	0	16.140	14.86	104.30	800.0	0.09495
## 490	1	16.690	20.20	107.10	857.6	0.07497
## 446	0	11.990	24.89	77.61	441.3	0.10300
## 45	1	13.170	21.81	85.42	531.5	0.09714
## 457	0	11.630	29.29	74.87	415.1	0.09357
## 209	0	13.110	22.54	87.02	529.4	0.10020
## 515	1	15.050	19.07	97.26	701.9	0.09215
## 454	0	14.530	13.98	93.86	644.2	0.10990
## 357	0	13.050	18.59	85.09	512.0	0.10820
## 555	0	12.880	28.92	82.50	514.3	0.08123
## 501	0	15.040	16.74	98.73	689.4	0.09883
## 185	1	15.280	22.41	98.92	710.6	0.09057
## 472	0	12.040	28.14	76.85	449.9	0.08752
## 485	0	15.730	11.28	102.80	747.2	0.10430
## 127	1	13.610	24.69	87.76	572.6	0.09258
## 559	0	14.590	22.68	96.39	657.1	0.08473
## 233	0	11.220	33.81	70.79	386.8	0.07780
## 422	0	14.690	13.98	98.22	656.1	0.10310
## 463	0	14.400	26.99	92.25	646.1	0.06995
## 289	0	11.260	19.96	73.72	394.1	0.08020
## 112	0	12.630	20.76	82.15	480.4	0.09933
## 505	0	9.268	12.87	61.49	248.7	

```
0.16340
## 32          1      11.840      18.70       77.93       440.6
0.11090
## 69          0       9.029      17.33       58.79       250.5
0.10660
## 553         0      12.770      29.43       81.35       507.9
0.08276
## 470         0      11.620      18.18       76.38       408.8
0.11750
## 149         0      14.440      15.18       93.97       640.1
0.09970
## 82          0      13.340      15.86       86.49       520.0
0.10780
## 380         1      11.080      18.83       73.30       361.6
0.12160
## 170         0      14.970      16.95       96.22       685.9
0.09855
## 424         0      13.660      19.13       89.46       575.3
0.09057
## 226         0      14.340      13.47       92.51       641.2
0.09906
## 50          0      13.490      22.30       86.91       561.0
0.08752
## 244         0      13.750      23.77       88.54       590.0
0.08043
## 216         1      13.860      16.93       90.96       578.9
0.10260
## 264         1      15.610      19.38      100.00       758.6
0.07840
## 556         0      10.290      27.61       65.67       321.4
0.09030
## 546         0      13.620      23.23       87.19       573.2
0.09246
## 458         0      13.210      25.25       84.10       537.9
0.08791
## 341         0      14.420      16.54       94.15       641.2
0.09751
## 519         0      12.880      18.22       84.45       493.1
0.12180
## 206         1      15.120      16.68       98.78       716.6
0.08876
## 161         0      11.750      20.18       76.10       419.8
0.10890
## 377         0      10.570      20.22       70.15       338.3
0.09073
## 453         0      12.000      28.23       76.77       442.5
0.08437
## 514         0      14.580      13.66       94.29       658.8
0.09832
## 124         0      14.500      10.89       94.28       640.7
```

```
0.11010
## 560          0       11.510      23.93       74.52       403.5
0.09261
## 449          0       14.530      19.34       94.25       659.7
0.08388
## 148          0       14.950      18.77       97.84       689.5
0.08138
## 201          0       12.230      19.56       78.54       461.0
0.09586
## 497          0       12.650      18.17       82.69       485.6
0.10760
## 172          1       13.430      19.63       85.84       565.4
0.09048
## 205          0       12.470      18.60       81.09       481.9
0.09965
## 467          0       13.140      20.74       85.98       536.9
0.08675
## 459          0       13.000      25.13       82.61       520.2
0.08369
## 378          0       13.460      28.21       85.89       562.1
0.07517
## 319          0        9.042      18.90       60.07       244.5
0.09968
## 527          0       13.460      18.75       87.44       551.1
0.10750
## 20           0       13.540      14.36       87.46       566.3
0.09779
## 477          0       14.200      20.53       92.41       618.4
0.08931
## 381          0       11.270      12.96       73.16       386.3
0.12370
## 448          0       14.800      17.66       95.88       674.8
0.09179
## 166          0       14.970      19.76       95.50       690.2
0.08421
## 89           0       12.360      21.80       79.78       466.1
0.08772
## 107          0       11.640      18.33       75.17       412.5
0.11420
## 249          0       10.650      25.22       68.01       347.0
0.09657
## 507          0       12.220      20.04       79.47       453.1
0.10960
## 362          0       13.300      21.57       85.24       546.1
0.08582
## 74           1       13.800      15.79       90.43       584.1
0.10070
## 62           0        8.598      20.98       54.66       221.8
0.12430
## 94           0       13.450      18.30       86.60       555.1
```

```
0.10220
## 524         0      13.710     18.68      88.73      571.0
0.09916
## 136         1      12.770     22.47      81.72      506.3
0.09055
## 222         0      13.560     13.90      88.59      561.3
0.10510
## 280         0      13.850     15.18      88.99      587.4
0.09516
## 474         0      12.270     29.97      77.42      465.4
0.07699
## 164         0      12.340     22.22      79.85      464.5
0.10120
## 228         0      15.000     15.51      97.45      684.5
0.08371
## 486         0      12.450     16.41      82.85      476.7
0.09514
## 246         0      10.480     19.86      66.72      337.7
0.10700
## 484         0      13.700     17.64      87.76      571.1
0.09950
## 503         0      12.540     16.32      81.25      476.3
0.11580
## 520         0      12.750     16.70      82.51      493.8
0.11250
## 423         0      11.610     16.02      75.46      408.2
0.10880
## 236         0      14.030     21.25      89.79      603.4
0.09070
## 552         0      11.130     22.44      71.49      378.4
0.09566
## 487         0      14.640     16.85      94.21      666.0
0.08641
## 356         0      12.560     19.07      81.92      485.8
0.08760
## 483         0      13.470     14.06      87.32      546.3
0.10710
## 81          0      11.450     20.97      73.81      401.5
0.11020
## 435         0      14.860     16.94      94.89      673.7
0.08924
## 192         0      12.770     21.41      82.02      507.4
0.08749
## 241         0      13.640     15.60      87.38      575.3
0.09423
## 531         0      11.750     17.56      75.89      422.9
0.10730
## 416         0      11.890     21.17      76.39      433.8
0.09773
## 41          1      13.440     21.58      86.18      563.0
```

```
        0.08162
## 540        0        7.691        25.44        48.34        170.4
        0.08668
## 545        0       13.870        20.70        89.77        584.8
        0.09578
## 395        0       12.100        17.72        78.07        446.2
        0.10290
## 460        0        9.755        28.20        61.68        290.9
        0.07984
## 104        0        9.876        19.40        63.95        298.3
        0.10050
## 114        0       10.510        20.19        68.64        334.2
        0.11220
## 229        0       12.620        23.97        81.35        496.4
        0.07903
## 270        0       10.710        20.39        69.50        344.9
        0.10820
## 332        0       12.980        19.35        84.52        514.0
        0.09579
## 345        0       11.710        15.45        75.03        420.3
        0.11500
## 508        0       11.060        17.12        71.25        366.5
        0.11940
## 425        0        9.742        19.12        61.93        289.7
        0.10750
## 506        0        9.676        13.14        64.12        272.5
        0.12550
## 417        0        9.405        21.70        59.60        271.2
        0.10440
## 116        0       11.930        21.53        76.53        438.6
        0.09768
## 300        0       10.510        23.09        66.85        334.2
        0.10150
## 439        0       13.850        19.60        88.68        592.6
        0.08684
## 489        0       11.680        16.17        75.49        420.5
        0.11280
## 140        0       11.280        13.39        73.00        384.8
        0.11640
## 155        0       13.150        15.34        85.31        538.9
        0.09384
## 516        0       11.340        18.61        72.76        391.2
        0.10490
## 473        0       14.920        14.93        96.45        686.9
        0.08098
## 466        0       13.240        20.13        86.87        542.9
        0.08284
## 348        0       14.760        14.74        94.87        668.7
        0.08875
## 512        0       14.810        14.70        94.66        680.7
```

0.08472

## 268	0	13.590	21.84	87.16	561.0
0.07956
## 532	0	11.670	20.02	75.21	416.2
0.10160
## 152	0	8.219	20.70	53.27	203.9
0.09405
## 287	0	11.940	20.76	77.87	441.0
0.08605
## 482	0	13.900	19.24	88.73	602.9
0.07991
## 97	0	12.180	17.84	77.79	451.1
0.10450
## 217	0	11.890	18.35	77.32	432.2
0.09363
## 293	0	12.950	16.02	83.14	513.7
0.10050
## 21	0	13.080	15.71	85.63	520.0
0.10750
## 396	0	14.060	17.18	89.75	609.1
0.08045
## 558	0	9.423	27.88	59.26	271.3
0.08123
## 428	0	10.800	21.98	68.79	359.9
0.08801
## 521	0	9.295	13.90	59.96	257.8
0.13710
## 80	0	12.860	18.00	83.19	506.3
0.09934
## 398	0	12.800	17.46	83.05	508.3
0.08044
## 306	0	11.600	24.49	74.23	417.2
0.07474
## 210	0	15.270	12.91	98.17	725.5
0.08182
## 70	0	12.780	16.49	81.37	502.5
0.09831
## 302	0	12.460	19.89	80.43	471.3
0.08451
## 56	0	11.520	18.75	73.34	409.0
0.09524
## 38	0	13.030	18.42	82.61	523.8
0.08983
## 438	0	14.040	15.98	89.78	611.2
0.08458
## 432	0	12.400	17.68	81.47	467.8
0.10540
## 410	0	12.270	17.92	78.41	466.1
0.08685
## 267	0	10.600	18.95	69.28	346.4

						0.09688
## 437	0	12.870	19.54	82.67	509.2	0.09136
## 232	0	11.320	27.08	71.76	395.7	0.06883
## 384	0	12.390	17.48	80.64	462.9	0.10420
## 298	1	11.760	18.14	75.00	431.1	0.09968
## 243	0	11.300	18.19	73.93	389.4	0.09592
## 326	0	12.670	17.30	81.25	489.9	0.10280
## 333	0	11.220	19.86	71.94	387.3	0.10540
## 321	0	10.250	16.18	66.52	324.2	0.10610
## 372	0	15.190	13.21	97.65	711.8	0.07963
## 420	0	11.160	21.41	70.95	380.3	0.10180
## 363	0	12.760	18.84	81.87	496.6	0.09676
## 550	0	10.820	24.21	68.89	361.6	0.08192
## 406	0	10.940	18.59	70.39	370.0	0.10040
## 562	0	11.200	29.37	70.67	386.0	0.07449
## 408	0	12.850	21.37	82.63	514.5	0.07551
## 67	0	9.465	21.01	60.11	269.4	0.10440
## 105	0	10.490	19.29	67.41	336.1	0.09989
## 269	0	12.870	16.21	82.38	512.2	0.09425
## 350	0	11.950	14.96	77.23	426.7	0.11580
## 207	0	9.876	17.27	62.92	295.4	0.10890
## 188	0	11.710	17.19	74.68	420.3	0.09774
## 323	0	12.860	13.32	82.82	504.8	0.11340
## 312	0	14.610	15.69	92.68	664.9	0.07618
## 412	0	11.040	16.83	70.92	373.2	0.10770
## 491	0	12.250	22.44	78.18	466.5	

```
0.08192
## 252        0    11.500    18.45    73.28    407.4
0.09345
## 476        0    12.830    15.73    82.89    506.9
0.09040
## 103        0    12.180    20.52    77.22    458.7
0.08013
## 177        0     9.904    18.06    64.60    302.4
0.09699
## 554        0     9.333    21.94    59.01    264.0
0.09240
## 171        0    12.320    12.39    78.85    464.1
0.10280
## 137        0    11.710    16.67    74.72    423.6
0.10510
## 290        0    11.370    18.89    72.17    396.0
0.08713
## 49         0    12.050    14.63    78.04    449.3
0.10310
## 368        0    12.210    18.02    78.31    458.4
0.09231
## 225        0    13.270    17.02    84.55    546.4
0.08445
## 465        0    13.170    18.22    84.28    537.3
0.07466
## 61         0    10.170    14.88    64.55    311.9
0.11340
## 375        0    13.690    16.07    87.84    579.1
0.08302
## 189        0    11.810    17.39    75.27    428.9
0.10070
## 156        0    12.250    17.94    78.27    460.3
0.08654
## 248        0    12.890    14.11    84.95    512.2
0.08760
## 539        0     7.729    25.49    47.98    178.8
0.08098
## 404        0    12.940    16.17    83.18    507.6
0.09879
## 250        0    11.520    14.93    73.87    406.3
0.10130
## 85         0    12.000    15.65    76.95    443.3
0.09723
## 110        0    11.340    21.26    72.48    396.5
0.08759
## 455        0    12.620    17.15    80.62    492.9
0.08583
## 440        0    14.020    15.66    89.59    606.5
0.07966
## 379        0    13.660    15.15    88.27    580.6
```

## 51	0	11.760	21.60	74.72	427.9	0.08637
## 146	0	11.900	14.65	78.11	432.8	0.11520
## 533	0	13.680	16.33	87.76	575.5	0.09277
## 144	0	12.900	15.92	83.74	512.2	0.08677
## 471	0	9.667	18.49	61.49	289.1	0.08946
## 75	0	12.310	16.52	79.19	470.9	0.09172
## 339	0	10.050	17.53	64.41	310.8	0.10070
## 495	0	13.160	20.54	84.06	538.7	0.07335
## 535	0	10.960	17.62	70.79	365.6	0.09687
## 143	0	11.430	17.31	73.66	398.0	0.10920
## 441	0	10.970	17.20	71.73	371.5	0.08915
## 304	0	10.490	18.61	66.86	334.3	0.10680
## 358	0	13.870	16.21	88.52	593.7	0.08743
## 285	0	12.890	15.70	84.08	516.6	0.07818
## 327	0	14.110	12.88	90.03	616.5	0.09309
## 223	0	10.180	17.53	65.12	313.1	0.10610
## 196	0	12.910	16.33	82.53	516.4	0.07941
## 403	0	12.960	18.29	84.18	525.2	0.07351
## 138	0	11.430	15.39	73.06	399.8	0.09639
## 343	0	11.060	14.96	71.49	373.9	0.10330
## 421	0	11.570	19.04	74.20	409.7	0.08546
## 294	0	11.850	17.46	75.54	432.7	0.08372
## 383	0	12.050	22.72	78.75	447.8	0.06935
## 126	0	13.850	17.21	88.44	588.7	0.08785
## 131	0	12.190	13.29	79.08	455.8	

```
0.10660
## 557           0       10.160        19.59          64.73        311.7
0.10030
## 279           0       13.590        17.84          86.24        572.3
0.07948
## 498           0       12.470        17.31          80.45        480.1
0.08928
## 150           0       13.740        17.91          88.12        585.0
0.07944
## 299           0       14.260        18.17          91.22        633.1
0.06576
## 59            0       13.050        19.31          82.61        527.2
0.08060
## 400           0       11.800        17.26          75.26        431.9
0.09087
## 68            0       11.310        19.04          71.80        394.1
0.08139
## 311           0       11.700        19.11          74.33        418.7
0.08814
## 530           0       12.070        13.44          77.83        445.2
0.11000
## 115           0        8.726        15.83          55.84        230.9
0.11500
## 444           0       10.570        18.32          66.82        340.9
0.08142
## 411           0       11.360        17.57          72.49        399.8
0.08858
## 315           0        8.597        18.60          54.09        221.2
0.10740
## 108           0       12.360        18.54          79.01        466.7
0.08477
## 360           0        9.436        18.32          59.82        278.6
0.10090
## 125           0       13.370        16.39          86.10        553.5
0.07115
## 479           0       11.490        14.59          73.99        404.9
0.10460
## 385           0       13.280        13.72          85.79        541.8
0.08363
## 365           0       13.400        16.95          85.48        552.4
0.07937
## 212           0       11.840        18.94          75.51        428.0
0.08871
## 478           0       13.900        16.62          88.97        599.4
0.06828
## 430           0       12.720        17.67          80.98        501.3
0.07896
## 464           0       11.600        18.36          73.88        412.7
0.08508
## 53            0       11.940        18.24          75.71        437.6
```

```
0.08261
## 481           0      12.160        18.03         78.29         455.3
0.09087
## 98            0       9.787        19.94         62.11         294.5
0.10240
## 541           0      11.540        14.44         74.65         402.9
0.09984
## 111           0       9.777        16.99         62.50         290.2
0.10370
## 296           0      13.770        13.27         88.06         582.7
0.09198
## 221           0      13.650        13.16         87.88         568.9
0.09646
## 93            0      13.270        14.76         84.74         551.7
0.07355
## 342           0       9.606        16.84         61.64         280.5
0.08481
## 451           0      11.870        21.54         76.83         432.0
0.06613
## 179           0      13.010        22.22         82.01         526.4
0.06251
## 443           0      13.780        15.79         88.37         585.9
0.08817
## 427           0      10.480        14.98         67.49         333.6
0.09816
## 335           0      12.300        19.02         77.88         464.4
0.08313
## 349           0      11.470        16.03         73.02         402.7
0.09076
## 286           0      12.580        18.40         79.83         489.0
0.08393
## 475           0      10.880        15.62         70.41         358.9
0.10070
## 247           0      13.200        17.43         84.13         541.6
0.07215
## 405           0      12.340        14.95         78.29         469.1
0.08682
## 174           0      11.080        14.71         70.21         372.7
0.10060
## 272           0      11.290        13.04         72.23         388.0
0.09834
## 305           0      11.460        18.16         73.59         403.1
0.08853
## 313           0      12.760        13.37         82.29         504.1
0.08794
## 282           0      11.740        14.02         74.24         427.3
0.07813
## 227           0      10.440        15.46         66.62         329.6
0.10530
## 548           0      10.260        16.58         65.85         320.8
```

```
0.08877
## 190          0      12.300       15.90        78.83        463.7
0.08080
## 549          0       9.683       19.34        61.05        285.7
0.08491
## 392          0       8.734       16.84        55.27        234.3
0.10390
## 274          0       9.742       15.67        61.50        289.9
0.09037
## 347          0      12.060       18.90        76.66        445.3
0.08386
## 389          0      11.270       15.50        73.38        392.0
0.08365
## 359          0       8.878       15.49        56.74        241.0
0.08293
## 295          0      12.720       13.78        81.78        492.1
0.09667
## 361          0      12.540       18.07        79.42        491.9
0.07436
## 388          0      13.880       16.16        88.37        596.6
0.07026
## 426          0      10.030       21.28        63.19        307.3
0.08117
## 218          0      10.200       17.48        65.05        321.2
0.08054
## 523          0      11.260       19.83        71.30        388.1
0.08511
## 52           0      13.640       16.34        87.21        571.8
0.07685
## 102          0       6.981       13.43        43.79        143.5
0.11700
## 271          0      14.290       16.82        90.30        632.6
0.06429
## 528          0      12.340       12.27        78.94        468.5
0.09003
## 320          0      12.430       17.00        78.60        477.3
0.07557
## 387          0      12.210       14.09        78.78        462.0
0.08108
## 117          0       8.950       15.76        58.74        245.2
0.09462
## 154          0      11.150       13.08        70.87        381.9
0.09754
## 337          0      12.990       14.23        84.08        514.3
0.09462
## 569          0       7.760       24.54        47.92        181.0
0.05263
## 547          0      10.320       16.35        65.31        324.9
0.09434
## 325          0      12.200       15.21        78.01        457.9
```

```
0.08673
## 72         0     8.888    14.64    58.79    244.0
0.09783
## 99         0    11.600    12.84    74.34    412.6
0.08983
## 551        0    10.860    21.48    68.51    360.5
0.07431
## 307        0    13.200    15.82    84.07    537.3
0.08511
## 184        0    11.410    14.92    73.53    402.0
0.09059
## 346        0    10.260    14.71    66.20    321.6
0.09882
## 413        0     9.397    21.68    59.75    268.8
0.07969
## 159        0    12.060    12.74    76.84    448.6
0.09311
## 382        0    11.040    14.93    70.67    372.7
0.07987
## 351        0    11.660    17.07    73.70    421.0
0.07561
## 525        0     9.847    15.68    63.00    293.2
0.09492
## 22         0     9.504    12.44    60.34    273.9
0.10240
## 64         0     9.173    13.86    59.20    260.9
0.07721
## 47         0     8.196    16.84    51.71    201.9
0.08600
## 277        0    11.330    14.16    71.79    396.6
0.09379
## 316        0    12.490    16.85    79.19    481.6
0.08511
## 310        0    13.050    13.84    82.71    530.6
0.08352
## 468        0     9.668    18.10    61.06    286.3
0.08311
## 419        0    12.700    12.17    80.88    495.0
0.08785
## 511        0    11.740    14.69    76.31    426.0
0.08099
## 526        0     8.571    13.10    54.53    221.3
0.10360
## 121        0    11.410    10.82    73.34    403.3
0.09373
## 391        0    10.260    12.22    65.75    321.6
0.09996
## 429        0    11.130    16.62    70.47    381.1
0.08151
## 235        0     9.567    15.91    60.21    279.6
```

```
0.08464
## 242            0       12.420        15.04           78.61       476.5
0.07926
## 186            0       10.080        15.11           63.76       317.5
0.09267
## 180            0       12.810        13.06           81.29       508.8
0.08739
## 402            0       11.930        10.91           76.14       442.7
0.08872
## 328            0       12.030        17.93           76.09       446.0
0.07683
## 175            0       10.660        15.15           67.49       349.6
0.08792
## 317            0       12.180        14.08           77.25       461.4
0.07734
## 334            0       11.250        14.78           71.38       390.0
0.08306
## 355            0       11.140        14.07           71.24       384.6
0.07274
## 309            0       13.500        12.71           85.69       566.2
0.07376
## 176            0        8.671        14.45           54.42       227.2
0.09138
## 145            0       10.750        14.97           68.26       355.3
0.07793
## 288            0       12.890        13.12           81.89       515.9
0.06955
## 399            0       11.060        14.83           70.31       378.2
0.07741
## 60             0        8.618        11.79           54.34       224.5
0.09752
## 193            0        9.720        18.22           60.73       288.1
0.06950
## 494            0       12.460        12.83           78.83       477.3
0.07372
## 297            0       10.910        12.35           69.14       363.7
0.08518
## 314            0       11.540        10.72           73.73       409.1
0.08597
## 141            0        9.738        11.97           61.24       288.5
0.09250
## 167            0       10.800         9.71           68.77       357.6
0.09594
## 160            0       10.900        12.96           68.69       366.8
0.07515
## 308            0        9.000        14.40           56.36       246.3
0.07005
##      compactness_mean concavity_mean concave.points_mean symmetry_mean
## 83            0.26650      0.3339000            0.184500        0.1829
## 123           0.28670      0.4268000            0.201200        0.2655
```

```
## 181      0.19140    0.2871000      0.187800      0.1800
## 203      0.20840    0.3523000      0.162000      0.2200
## 213      0.15160    0.3201000      0.159500      0.1648
## 340      0.12830    0.2308000      0.141000      0.1797
## 353      0.23630    0.3368000      0.191300      0.1956
## 462      0.19880    0.3635000      0.168900      0.2061
## 522      0.21060    0.2310000      0.147100      0.1991
## 109      0.27680    0.4264000      0.182300      0.2556
## 237      0.16820    0.1950000      0.123700      0.1909
## 565      0.11590    0.2439000      0.138900      0.1726
## 370      0.19540    0.2448000      0.150100      0.1824
## 394      0.20870    0.2810000      0.156200      0.2162
## 568      0.27700    0.3514000      0.152000      0.2397
## 504      0.12750    0.1676000      0.100300      0.1505
## 165      0.11450    0.1324000      0.097020      0.1801
## 564      0.22360    0.3174000      0.147400      0.2149
## 79       0.34540    0.3754000      0.160400      0.2906
## 266      0.11430    0.1367000      0.086460      0.1769
## 251      0.16060    0.2712000      0.131000      0.2205
## 182      0.28320    0.2487000      0.149600      0.2395
## 324      0.18750    0.2565000      0.150400      0.2569
## 273      0.19610    0.2195000      0.108800      0.1721
## 369      0.08562    0.1168000      0.084650      0.1717
## 536      0.17390    0.2085000      0.132200      0.2127
## 303      0.18380    0.2283000      0.128000      0.2249
## 84       0.17910    0.1937000      0.146900      0.1634
## 500      0.16440    0.2188000      0.112100      0.1848
## 450      0.11750    0.1572000      0.115500      0.1554
## 261      0.10880    0.1519000      0.093330      0.1814
## 24       0.10220    0.1097000      0.086320      0.1769
## 367      0.16690    0.1641000      0.126500      0.1875
## 566      0.10340    0.1440000      0.097910      0.1752
## 257      0.20630    0.1784000      0.114400      0.1893
## 3        0.15990    0.1974000      0.127900      0.2069
## 130      0.15890    0.2545000      0.114900      0.2202
## 163      0.16660    0.2508000      0.128600      0.2027
## 234      0.10740    0.1554000      0.083400      0.1448
## 433      0.14890    0.2133000      0.125900      0.1724
## 373      0.15150    0.1932000      0.125500      0.1973
## 31       0.18870    0.2319000      0.124400      0.2183
## 534      0.13130    0.1523000      0.101500      0.2166
## 19       0.10270    0.1479000      0.094980      0.1582
## 301      0.16420    0.2197000      0.106200      0.1792
## 220      0.11300    0.1145000      0.066370      0.1428
## 211      0.13480    0.1640000      0.095610      0.1765
## 344      0.13390    0.1863000      0.110300      0.2082
## 452      0.09871    0.1655000      0.090630      0.1663
## 281      0.14530    0.1921000      0.096640      0.1902
## 96       0.13130    0.1465000      0.086830      0.2095
## 390      0.13180    0.1856000      0.102100      0.1989
```

```
## 488         0.14480       0.2256000       0.119400       0.1823
## 240         0.12980       0.1417000       0.088110       0.1809
## 374         0.10760       0.1527000       0.089410       0.1571
## 5           0.13280       0.1980000       0.104300       0.1809
## 219         0.13060       0.1272000       0.086910       0.2094
## 253         0.18490       0.2417000       0.097400       0.1733
## 245         0.15580       0.2049000       0.088860       0.1978
## 33          0.14960       0.2417000       0.120300       0.2248
## 13          0.24580       0.2065000       0.111800       0.2397
## 401         0.25760       0.3189000       0.119800       0.2113
## 366         0.11310       0.0979900       0.077850       0.1618
## 518         0.13100       0.1411000       0.094310       0.1802
## 34          0.17190       0.1657000       0.075930       0.1853
## 43          0.21900       0.2107000       0.099610       0.2310
## 322         0.08564       0.1155000       0.077260       0.1928
## 169         0.16030       0.2159000       0.104300       0.1538
## 26          0.22760       0.2229000       0.140100       0.3040
## 434         0.13890       0.1594000       0.087440       0.1943
## 2           0.07864       0.0869000       0.070170       0.1812
## 255         0.11880       0.1379000       0.085910       0.1776
## 238         0.08348       0.0904200       0.060220       0.1467
## 57          0.12670       0.1323000       0.089940       0.1917
## 54          0.14850       0.1772000       0.106000       0.2092
## 447         0.13140       0.1698000       0.082930       0.1713
## 517         0.12480       0.1569000       0.094510       0.1860
## 283         0.14420       0.1626000       0.094640       0.1893
## 259         0.31140       0.3176000       0.137700       0.2495
## 46          0.16860       0.1974000       0.100900       0.1907
## 1           0.27760       0.3001000       0.147100       0.2419
## 157         0.16650       0.1855000       0.105400       0.1971
## 88          0.12060       0.1468000       0.082710       0.1953
## 71          0.10290       0.1080000       0.079510       0.1582
## 86          0.10530       0.1335000       0.087950       0.2132
## 260         0.16390       0.1751000       0.083990       0.2091
## 162         0.11850       0.1193000       0.096670       0.1741
## 25          0.14570       0.1525000       0.091700       0.1995
## 28          0.10660       0.1490000       0.077310       0.1697
## 199         0.14280       0.1114000       0.067720       0.1767
## 336         0.10560       0.1508000       0.099340       0.1727
## 563         0.20870       0.2550000       0.094290       0.2128
## 469         0.20040       0.2136000       0.100200       0.1696
## 231         0.15720       0.1910000       0.109000       0.2131
## 122         0.11000       0.1457000       0.086650       0.1966
## 73          0.18300       0.1692000       0.079440       0.1927
## 135         0.09709       0.1153000       0.068470       0.1692
## 352         0.23640       0.2914000       0.124200       0.2375
## 78          0.21460       0.1684000       0.108000       0.2152
## 499         0.13170       0.1491000       0.091830       0.1832
## 409         0.13040       0.1201000       0.088240       0.1992
## 461         0.11100       0.1007000       0.064310       0.1793
```

```
## 493          0.12890          0.1170000                  0.077620          0.2116
## 128          0.08028          0.0927100                  0.056270          0.1946
## 258          0.22840          0.2448000                  0.124200          0.2398
## 338          0.14020          0.1060000                  0.060900          0.1953
## 119          0.17520          0.2133000                  0.094790          0.2096
## 214          0.11460          0.1682000                  0.065970          0.1308
## 7            0.10900          0.1127000                  0.074000          0.1794
## 371          0.14970          0.1811000                  0.087730          0.2175
## 418          0.15710          0.1522000                  0.084810          0.2085
## 318          0.11170          0.1130000                  0.079500          0.1807
## 263          0.12730          0.0969700                  0.075070          0.2108
## 278          0.05884          0.0802000                  0.058430          0.1550
## 330          0.12830          0.1799000                  0.079810          0.1869
## 18           0.20220          0.1722000                  0.102800          0.2164
## 29           0.16970          0.1683000                  0.087510          0.1926
## 204          0.17680          0.1558000                  0.091760          0.2251
## 329          0.13190          0.1478000                  0.084880          0.1948
## 265          0.08995          0.0906100                  0.065270          0.1867
## 16           0.15950          0.1639000                  0.073640          0.2303
## 510          0.18700          0.2030000                  0.085200          0.1807
## 480          0.18930          0.2236000                  0.091940          0.2151
## 254          0.10410          0.1266000                  0.083530          0.1813
## 275          0.07027          0.0569900                  0.047440          0.1538
## 198          0.08642          0.1103000                  0.057780          0.1770
## 393          0.15620          0.1891000                  0.091130          0.1929
## 442          0.11090          0.1204000                  0.057360          0.1467
## 66           0.14790          0.1267000                  0.090290          0.1953
## 431          0.22250          0.2733000                  0.097110          0.2041
## 178          0.15560          0.1793000                  0.088660          0.1794
## 567          0.10230          0.0925100                  0.053020          0.1590
## 120          0.06722          0.0729300                  0.055960          0.2129
## 187          0.08468          0.0816900                  0.058140          0.1621
## 202          0.11980          0.1036000                  0.074880          0.1506
## 132          0.12230          0.1466000                  0.080870          0.1931
## 284          0.18020          0.1948000                  0.090520          0.1876
## 36           0.13360          0.1348000                  0.060180          0.1896
## 9            0.19320          0.1859000                  0.093530          0.2350
## 354          0.09769          0.1235000                  0.065530          0.1647
## 30           0.11570          0.0987500                  0.079530          0.1739
## 173          0.15550          0.2032000                  0.109700          0.1966
## 153          0.15990          0.4108000                  0.078570          0.2548
## 63           0.20080          0.2135000                  0.086530          0.1949
## 208          0.07304          0.0695000                  0.053900          0.2026
## 95           0.15530          0.1700000                  0.088150          0.1855
## 133          0.12840          0.1043000                  0.056130          0.2160
## 4            0.28390          0.2414000                  0.105200          0.2597
## 168          0.09182          0.0842200                  0.065760          0.1893
## 195          0.19800          0.1697000                  0.088780          0.1737
## 502          0.16810          0.1357000                  0.067590          0.2275
## 58           0.13650          0.1293000                  0.081230          0.2027
```

```
## 35     0.15590    0.1354000    0.077520    0.1998
## 445    0.12320    0.1090000    0.062540    0.1720
## 76     0.08424    0.0976900    0.066380    0.1798
## 118    0.16490    0.1690000    0.089230    0.2157
## 139    0.13050    0.1539000    0.086240    0.1957
## 27     0.18680    0.1425000    0.087830    0.2252
## 10     0.23960    0.2273000    0.085430    0.2030
## 92     0.10360    0.1122000    0.074830    0.1717
## 14     0.10020    0.0993800    0.053640    0.1847
## 15     0.22930    0.2128000    0.080250    0.2069
## 106    0.17650    0.2071000    0.096010    0.1925
## 224    0.12040    0.1147000    0.064620    0.1935
## 23     0.21350    0.2077000    0.097560    0.2521
## 197    0.12670    0.1385000    0.065260    0.1834
## 415    0.04605    0.0468600    0.027390    0.1852
## 262    0.06290    0.0289100    0.028370    0.1564
## 537    0.11540    0.1463000    0.061390    0.1926
## 129    0.18070    0.1138000    0.085340    0.2001
## 191    0.24130    0.1981000    0.066180    0.2384
## 65     0.12620    0.1128000    0.068730    0.1905
## 513    0.14690    0.1445000    0.081720    0.2116
## 142    0.11370    0.0944700    0.059430    0.1861
## 12     0.12920    0.0995400    0.066060    0.1842
## 215    0.13060    0.1115000    0.064620    0.2235
## 276    0.07210    0.0592900    0.074040    0.2015
## 183    0.08799    0.0659300    0.051890    0.1618
## 364    0.08468    0.0586200    0.048350    0.1495
## 230    0.17990    0.1695000    0.068610    0.2123
## 48     0.12310    0.1226000    0.073400    0.2128
## 37     0.10980    0.1319000    0.055980    0.1885
## 331    0.13710    0.1204000    0.070410    0.1782
## 8      0.16450    0.0936600    0.059850    0.2196
## 113    0.22330    0.3003000    0.077980    0.1704
## 87     0.09947    0.1204000    0.049380    0.2075
## 542    0.12300    0.1009000    0.038900    0.1872
## 386    0.06636    0.0839000    0.052710    0.1627
## 194    0.13530    0.1085000    0.045620    0.1943
## 90     0.13390    0.0996600    0.070640    0.2116
## 456    0.07426    0.0281900    0.032640    0.1375
## 561    0.11260    0.0446200    0.043040    0.1537
## 17     0.07200    0.0739500    0.052590    0.1586
## 492    0.06217    0.0444500    0.041780    0.1220
## 239    0.10390    0.1103000    0.044080    0.1342
## 200    0.12060    0.1180000    0.059800    0.1950
## 101    0.08511    0.0862500    0.044890    0.1609
## 6      0.17000    0.1578000    0.080890    0.2087
## 158    0.07223    0.0515000    0.027710    0.1844
## 39     0.05131    0.0239800    0.028990    0.1565
## 11     0.06669    0.0329900    0.033230    0.1528
## 436    0.11330    0.1126000    0.064630    0.1669
```

```
## 538         0.15520      0.0451500           0.045310       0.2131
## 509         0.06712      0.0552600           0.045630       0.1711
## 100         0.11410      0.0938800           0.058390       0.1879
## 529         0.09755      0.1010000           0.066150       0.1976
## 42          0.12180      0.1044000           0.056690       0.1895
## 376         0.14380      0.0665100           0.053970       0.1990
## 291         0.16760      0.1362000           0.066020       0.1714
## 44          0.14360      0.0984700           0.061580       0.1974
## 543         0.07214      0.0410500           0.030270       0.1840
## 496         0.08345      0.0682400           0.049510       0.1487
## 414         0.10250      0.0685900           0.038760       0.1944
## 55          0.07081      0.0525300           0.033340       0.1616
## 147         0.17000      0.1659000           0.074150       0.2678
## 151         0.07589      0.0313600           0.026450       0.2540
## 134         0.09462      0.0713500           0.059330       0.1816
## 544         0.06877      0.0298700           0.032750       0.1628
## 40          0.12550      0.1063000           0.054390       0.1720
## 77          0.10470      0.0687700           0.065560       0.2403
## 292         0.09823      0.0594000           0.048190       0.1879
## 91          0.08606      0.0310200           0.029570       0.1685
## 256         0.12790      0.0978900           0.052460       0.1908
## 397         0.11470      0.0858000           0.053810       0.1806
## 407         0.08501      0.0550000           0.045280       0.1735
## 490         0.07112      0.0364900           0.023070       0.1846
## 446         0.09218      0.0544100           0.042740       0.1820
## 45          0.10470      0.0825900           0.052520       0.1746
## 457         0.08574      0.0716000           0.020170       0.1799
## 209         0.14830      0.0870500           0.051020       0.1850
## 515         0.08597      0.0748600           0.043350       0.1561
## 454         0.09242      0.0689500           0.064950       0.1650
## 357         0.13040      0.0960300           0.056030       0.2035
## 555         0.05824      0.0619500           0.023430       0.1566
## 501         0.13640      0.0772100           0.061420       0.1668
## 185         0.10520      0.0537500           0.032630       0.1727
## 472         0.06000      0.0236700           0.023770       0.1854
## 485         0.12990      0.1191000           0.062110       0.1784
## 127         0.07862      0.0528500           0.030850       0.1761
## 559         0.13300      0.1029000           0.037360       0.1454
## 233         0.03574      0.0049670           0.006434       0.1845
## 422         0.18360      0.1450000           0.063000       0.2086
## 463         0.05223      0.0347600           0.017370       0.1707
## 289         0.11810      0.0927400           0.055880       0.2595
## 112         0.12090      0.1065000           0.060210       0.1735
## 505         0.22390      0.0973000           0.052520       0.2378
## 32          0.15160      0.1218000           0.051820       0.2301
## 69          0.14130      0.3130000           0.043750       0.2111
## 553         0.04234      0.0199700           0.014990       0.1539
## 470         0.14830      0.1020000           0.055640       0.1957
## 149         0.10210      0.0848700           0.055320       0.1724
## 82          0.15350      0.1169000           0.069870       0.1942
```

```
## 380           0.21540       0.1689000              0.063670             0.2196
## 170           0.07885       0.0260200              0.037810             0.1780
## 424           0.11470       0.0965700              0.048120             0.1848
## 226           0.07624       0.0572400              0.046030             0.2075
## 50            0.07698       0.0475100              0.033840             0.1809
## 244           0.06807       0.0469700              0.023440             0.1773
## 216           0.15170       0.0990100              0.056020             0.2106
## 264           0.05616       0.0420900              0.028470             0.1547
## 556           0.07658       0.0599900              0.027380             0.1593
## 546           0.06747       0.0297400              0.024430             0.1664
## 458           0.05205       0.0277200              0.020680             0.1619
## 341           0.11390       0.0800700              0.042230             0.1912
## 519           0.16610       0.0482500              0.053030             0.1709
## 206           0.09588       0.0755000              0.040790             0.1594
## 161           0.11410       0.0684300              0.037380             0.1993
## 377           0.16600       0.2280000              0.059410             0.2188
## 453           0.06450       0.0405500              0.019450             0.1615
## 514           0.08918       0.0822200              0.043490             0.1739
## 124           0.10990       0.0884200              0.057780             0.1856
## 560           0.10210       0.1112000              0.041050             0.1388
## 449           0.07800       0.0881700              0.029250             0.1473
## 148           0.11670       0.0905000              0.035620             0.1744
## 201           0.08087       0.0418700              0.041070             0.1979
## 497           0.13340       0.0801700              0.050740             0.1641
## 172           0.06288       0.0585800              0.034380             0.1598
## 205           0.10580       0.0800500              0.038210             0.1925
## 467           0.10890       0.1085000              0.035100             0.1562
## 459           0.05073       0.0120600              0.017620             0.1667
## 378           0.04726       0.0127100              0.011170             0.1421
## 319           0.19720       0.1975000              0.049080             0.2330
## 527           0.11380       0.0420100              0.031520             0.1723
## 20            0.08129       0.0666400              0.047810             0.1885
## 477           0.11080       0.0506300              0.030580             0.1506
## 381           0.11110       0.0790000              0.055500             0.2018
## 448           0.08890       0.0406900              0.022600             0.1893
## 166           0.05352       0.0194700              0.019390             0.1515
## 89            0.09445       0.0601500              0.037450             0.1930
## 107           0.10170       0.0707000              0.034850             0.1801
## 249           0.07234       0.0237900              0.016150             0.1897
## 507           0.11520       0.0817500              0.021660             0.2124
## 362           0.06373       0.0334400              0.024240             0.1815
## 74            0.12800       0.0778900              0.050690             0.1662
## 62            0.08963       0.0300000              0.009259             0.1828
## 94            0.08165       0.0397400              0.027800             0.1638
## 524           0.10700       0.0538500              0.037830             0.1714
## 136           0.05761       0.0471100              0.027040             0.1585
## 222           0.11920       0.0786000              0.044510             0.1962
## 280           0.07688       0.0447900              0.037110             0.2110
## 474           0.03398       0.0000000              0.000000             0.1701
## 164           0.10150       0.0537000              0.028220             0.1551
```

```
## 228        0.10960        0.0650500        0.037800        0.1881
## 486        0.15110        0.1544000        0.048460        0.2082
## 246        0.05971        0.0483100        0.030700        0.1737
## 484        0.07957        0.0454800        0.031600        0.1732
## 503        0.10850        0.0592800        0.032790        0.1943
## 520        0.11170        0.0388000        0.029950        0.2120
## 423        0.11680        0.0709700        0.044970        0.1886
## 236        0.06945        0.0146200        0.018960        0.1517
## 552        0.08194        0.0482400        0.022570        0.2030
## 487        0.06698        0.0519200        0.027910        0.1409
## 356        0.10380        0.1030000        0.043910        0.1533
## 483        0.11550        0.0578600        0.052660        0.1779
## 81         0.09362        0.0459100        0.022330        0.1842
## 435        0.07074        0.0334600        0.028770        0.1573
## 192        0.06601        0.0311200        0.028640        0.1694
## 241        0.06630        0.0470500        0.037310        0.1717
## 531        0.09713        0.0528200        0.044400        0.1598
## 416        0.08120        0.0255500        0.021790        0.2019
## 41         0.06031        0.0311000        0.020310        0.1784
## 540        0.11990        0.0925200        0.013640        0.2037
## 545        0.10180        0.0368800        0.023690        0.1620
## 395        0.09758        0.0478300        0.033260        0.1937
## 460        0.04626        0.0154100        0.010430        0.1621
## 104        0.09697        0.0615400        0.030290        0.1945
## 114        0.13030        0.0647600        0.030680        0.1922
## 229        0.07529        0.0543800        0.020360        0.1514
## 270        0.12890        0.0844800        0.028670        0.1668
## 332        0.11250        0.0710700        0.029500        0.1761
## 345        0.07281        0.0400600        0.032500        0.2009
## 508        0.10710        0.0406300        0.042680        0.1954
## 425        0.08333        0.0089340        0.019670        0.2538
## 506        0.22040        0.1188000        0.070380        0.2057
## 417        0.06159        0.0204700        0.012570        0.2025
## 116        0.07849        0.0332800        0.020080        0.1688
## 300        0.06797        0.0249500        0.018750        0.1695
## 439        0.06330        0.0134200        0.022930        0.1555
## 489        0.09263        0.0427900        0.031320        0.1853
## 140        0.11360        0.0463500        0.047960        0.1771
## 155        0.08498        0.0929300        0.034830        0.1822
## 516        0.08499        0.0430200        0.025940        0.1927
## 473        0.08549        0.0553900        0.032210        0.1687
## 466        0.12230        0.1010000        0.028330        0.1601
## 348        0.07780        0.0460800        0.035280        0.1521
## 512        0.05016        0.0341600        0.025410        0.1659
## 268        0.08259        0.0407200        0.021420        0.1635
## 532        0.09453        0.0420000        0.021570        0.1859
## 152        0.13050        0.1321000        0.021680        0.2222
## 287        0.10110        0.0657400        0.037910        0.1588
## 482        0.05326        0.0299500        0.020700        0.1579
## 97         0.07057        0.0249000        0.029410        0.1900
```

## 217	0.11540	0.0663600	0.031420	0.1967
## 293	0.07943	0.0615500	0.033700	0.1730
## 21	0.12700	0.0456800	0.031100	0.1967
## 396	0.05361	0.0268100	0.032510	0.1641
## 558	0.04971	0.0000000	0.000000	0.1742
## 428	0.05743	0.0361400	0.014040	0.2016
## 521	0.12250	0.0333200	0.024210	0.2197
## 80	0.09546	0.0388900	0.023150	0.1718
## 398	0.08895	0.0739000	0.040830	0.1574
## 306	0.05688	0.0197400	0.013130	0.1935
## 210	0.06230	0.0589200	0.031570	0.1359
## 70	0.05234	0.0365300	0.028640	0.1590
## 302	0.10140	0.0683000	0.030990	0.1781
## 56	0.05473	0.0303600	0.022780	0.1920
## 38	0.03766	0.0256200	0.029230	0.1467
## 438	0.05895	0.0353400	0.029440	0.1714
## 432	0.13160	0.0774100	0.027990	0.1811
## 410	0.06526	0.0321100	0.026530	0.1966
## 267	0.11470	0.0638700	0.026420	0.1922
## 437	0.07883	0.0179700	0.020900	0.1861
## 232	0.03813	0.0163300	0.003125	0.1869
## 384	0.12970	0.0589200	0.028800	0.1779
## 298	0.05914	0.0268500	0.035150	0.1619
## 243	0.13250	0.1548000	0.028540	0.2054
## 326	0.07664	0.0319300	0.021070	0.1707
## 333	0.06779	0.0050060	0.007583	0.1940
## 321	0.11110	0.0672600	0.039650	0.1743
## 372	0.06934	0.0339300	0.026570	0.1721
## 420	0.05978	0.0089550	0.010760	0.1615
## 363	0.07952	0.0268800	0.017810	0.1759
## 550	0.06602	0.0154800	0.008160	0.1976
## 406	0.07460	0.0494400	0.029320	0.1486
## 562	0.03558	0.0000000	0.000000	0.1060
## 408	0.08316	0.0612600	0.018670	0.1580
## 67	0.07773	0.0217200	0.015040	0.1717
## 105	0.08578	0.0299500	0.012010	0.2217
## 269	0.06219	0.0390000	0.016150	0.2010
## 350	0.12060	0.0117100	0.017870	0.2459
## 207	0.07232	0.0175600	0.019520	0.1934
## 188	0.06141	0.0380900	0.032390	0.1516
## 323	0.08834	0.0380000	0.034000	0.1543
## 312	0.03515	0.0144700	0.018770	0.1632
## 412	0.07804	0.0304600	0.024800	0.1714
## 491	0.05200	0.0171400	0.012610	0.1544
## 252	0.05991	0.0263800	0.020690	0.1834
## 476	0.08269	0.0583500	0.030780	0.1705
## 103	0.04038	0.0238300	0.017700	0.1739
## 177	0.12940	0.1307000	0.037160	0.1669
## 554	0.05605	0.0399600	0.012820	0.1692
## 171	0.06981	0.0398700	0.037000	0.1959

```
## 137          0.06095       0.0359200         0.026000       0.1339
## 290          0.05008       0.0239900         0.021730       0.2013
## 49           0.09092       0.0659200         0.027490       0.1675
## 368          0.07175       0.0439200         0.020270       0.1695
## 225          0.04994       0.0355400         0.024560       0.1496
## 465          0.05994       0.0485900         0.028700       0.1454
## 61           0.08061       0.0108400         0.012900       0.2743
## 375          0.06374       0.0255600         0.020310       0.1872
## 189          0.05562       0.0235300         0.015530       0.1718
## 156          0.06679       0.0388500         0.023310       0.1970
## 248          0.13460       0.1374000         0.039800       0.1596
## 539          0.04878       0.0000000         0.000000       0.1870
## 404          0.08836       0.0329600         0.023900       0.1735
## 250          0.07808       0.0432800         0.029290       0.1883
## 85           0.07165       0.0415100         0.018630       0.2079
## 110          0.06575       0.0513300         0.018990       0.1487
## 455          0.05430       0.0296600         0.022720       0.1799
## 440          0.05581       0.0208700         0.026520       0.1589
## 379          0.07548       0.0424900         0.024710       0.1792
## 51           0.04966       0.0165700         0.011150       0.1495
## 146          0.12960       0.0371000         0.030030       0.1995
## 533          0.07255       0.0175200         0.018800       0.1631
## 144          0.09509       0.0489400         0.030880       0.1778
## 471          0.06258       0.0294800         0.015140       0.2238
## 75           0.06829       0.0337200         0.022720       0.1720
## 339          0.07326       0.0251100         0.017750       0.1890
## 495          0.05275       0.0180000         0.012560       0.1713
## 535          0.09752       0.0526300         0.027880       0.1619
## 143          0.09486       0.0203100         0.018610       0.1645
## 441          0.11130       0.0945700         0.036130       0.1489
## 304          0.06678       0.0229700         0.017800       0.1482
## 358          0.05492       0.0150200         0.020880       0.1424
## 285          0.09580       0.1115000         0.033900       0.1432
## 327          0.05306       0.0176500         0.027330       0.1373
## 223          0.08502       0.0176800         0.019150       0.1910
## 196          0.05366       0.0387300         0.023770       0.1829
## 403          0.07899       0.0405700         0.018830       0.1874
## 138          0.06889       0.0350300         0.028750       0.1734
## 343          0.09097       0.0539700         0.033410       0.1776
## 421          0.07722       0.0548500         0.014280       0.2031
## 294          0.05642       0.0268800         0.022800       0.1875
## 383          0.10730       0.0794300         0.029780       0.1203
## 126          0.06136       0.0142000         0.011410       0.1614
## 131          0.09509       0.0285500         0.028820       0.1880
## 557          0.07504       0.0050250         0.011160       0.1791
## 279          0.04052       0.0199700         0.012380       0.1573
## 498          0.07630       0.0360900         0.023690       0.1526
## 150          0.06376       0.0288100         0.013290       0.1473
## 299          0.05220       0.0247500         0.013740       0.1635
## 59           0.03789       0.0006920         0.004167       0.1819
```

```
## 400        0.06232      0.0285300          0.016380        0.1847
## 68         0.04701      0.0370900          0.022300        0.1516
## 311        0.05253      0.0158300          0.011480        0.1936
## 530        0.09009      0.0378100          0.027980        0.1657
## 115        0.08201      0.0413200          0.019240        0.1649
## 444        0.04462      0.0199300          0.011110        0.2372
## 411        0.05313      0.0278300          0.021000        0.1601
## 315        0.05847      0.0000000          0.000000        0.2163
## 108        0.06815      0.0264300          0.019210        0.1602
## 360        0.05956      0.0271000          0.014060        0.1506
## 125        0.07325      0.0809200          0.028000        0.1422
## 479        0.08228      0.0530800          0.019690        0.1779
## 385        0.08575      0.0507700          0.028640        0.1617
## 365        0.05696      0.0218100          0.014730        0.1650
## 212        0.06900      0.0266900          0.013930        0.1533
## 478        0.05319      0.0222400          0.013390        0.1813
## 430        0.04522      0.0140200          0.018350        0.1459
## 464        0.05855      0.0336700          0.017770        0.1516
## 53         0.04751      0.0197200          0.013490        0.1868
## 481        0.07838      0.0291600          0.015270        0.1464
## 98         0.05301      0.0068290          0.007937        0.1350
## 541        0.11200      0.0673700          0.025940        0.1818
## 111        0.08404      0.0433400          0.017780        0.1584
## 296        0.06221      0.0106300          0.019170        0.1592
## 221        0.08711      0.0388800          0.025630        0.1360
## 93         0.05055      0.0326100          0.026480        0.1386
## 342        0.09228      0.0842200          0.022920        0.2036
## 451        0.10640      0.0877700          0.023860        0.1349
## 179        0.01938      0.0015950          0.001852        0.1395
## 443        0.06718      0.0105500          0.009937        0.1405
## 427        0.10130      0.0633500          0.022180        0.1925
## 335        0.04202      0.0077560          0.008535        0.1539
## 349        0.05886      0.0258700          0.023220        0.1634
## 286        0.04216      0.0018600          0.002924        0.1697
## 475        0.10690      0.0511500          0.015710        0.1861
## 247        0.04524      0.0433600          0.011050        0.1487
## 405        0.04571      0.0210900          0.020540        0.1571
## 174        0.05743      0.0236300          0.025830        0.1566
## 272        0.07608      0.0326500          0.027550        0.1769
## 305        0.07694      0.0334400          0.015020        0.1411
## 313        0.07948      0.0405200          0.025480        0.1601
## 282        0.04340      0.0224500          0.027630        0.2101
## 227        0.07722      0.0066430          0.012160        0.1788
## 548        0.08066      0.0435800          0.024380        0.1669
## 190        0.07253      0.0384400          0.016540        0.1667
## 549        0.05030      0.0233700          0.009615        0.1580
## 392        0.07428      0.0000000          0.000000        0.1985
## 274        0.04689      0.0110300          0.014070        0.2081
## 347        0.05794      0.0075100          0.008488        0.1555
## 389        0.11140      0.1007000          0.027570        0.1810
```

## 359	0.07698	0.0472100	0.023810	0.1930
## 295	0.08393	0.0128800	0.019240	0.1638
## 361	0.02650	0.0011940	0.005449	0.1528
## 388	0.04831	0.0204500	0.008507	0.1607
## 426	0.03912	0.0024700	0.005159	0.1630
## 218	0.05907	0.0577400	0.010710	0.1964
## 523	0.04413	0.0050670	0.005664	0.1637
## 52	0.06059	0.0185700	0.017230	0.1353
## 102	0.07568	0.0000000	0.000000	0.1930
## 271	0.02675	0.0072500	0.006250	0.1508
## 528	0.06307	0.0295800	0.026470	0.1689
## 320	0.03454	0.0134200	0.016990	0.1472
## 387	0.07823	0.0683900	0.025340	0.1646
## 117	0.12430	0.0926300	0.023080	0.1305
## 154	0.05113	0.0198200	0.017860	0.1830
## 337	0.09965	0.0373800	0.020980	0.1652
## 569	0.04362	0.0000000	0.000000	0.1587
## 547	0.04994	0.0101200	0.005495	0.1885
## 325	0.06545	0.0199400	0.016920	0.1638
## 72	0.15310	0.0860600	0.028720	0.1902
## 99	0.07525	0.0419600	0.033500	0.1620
## 551	0.04227	0.0000000	0.000000	0.1661
## 307	0.05251	0.0014610	0.003261	0.1632
## 184	0.08155	0.0618100	0.023610	0.1167
## 346	0.09159	0.0358100	0.020370	0.1633
## 413	0.06053	0.0373500	0.005128	0.1274
## 159	0.05241	0.0197200	0.019630	0.1590
## 382	0.07079	0.0354600	0.020740	0.2003
## 351	0.03630	0.0083060	0.011620	0.1671
## 525	0.08419	0.0233000	0.024160	0.1387
## 22	0.06492	0.0295600	0.020760	0.1815
## 64	0.08751	0.0598800	0.021800	0.2341
## 47	0.05943	0.0158800	0.005917	0.1769
## 277	0.03872	0.0014870	0.003333	0.1954
## 316	0.03834	0.0044730	0.006423	0.1215
## 310	0.03735	0.0045590	0.008829	0.1453
## 468	0.05428	0.0147900	0.005769	0.1680
## 419	0.05794	0.0236000	0.024020	0.1583
## 511	0.09661	0.0672600	0.026390	0.1499
## 526	0.07632	0.0256500	0.015100	0.1678
## 121	0.06685	0.0351200	0.026230	0.1667
## 391	0.07542	0.0192300	0.019680	0.1800
## 429	0.03834	0.0136900	0.013700	0.1511
## 235	0.04087	0.0165200	0.016670	0.1551
## 242	0.03393	0.0105300	0.011080	0.1546
## 186	0.04695	0.0015970	0.002404	0.1703
## 180	0.03774	0.0091930	0.013300	0.1466
## 402	0.05242	0.0260600	0.017960	0.1601
## 328	0.03892	0.0015460	0.005592	0.1382
## 175	0.04302	0.0000000	0.000000	0.1928

```
## 317               0.03212      0.0112300              0.005051     0.1673
## 334               0.04458      0.0009737              0.002941     0.1773
## 355               0.06064      0.0450500              0.014710     0.1690
## 309               0.03614      0.0027580              0.004419     0.1365
## 176               0.04276      0.0000000              0.000000     0.1722
## 145               0.05139      0.0225100              0.007875     0.1399
## 288               0.03729      0.0226000              0.011710     0.1337
## 399               0.04768      0.0271200              0.007246     0.1535
## 60                0.05272      0.0206100              0.007799     0.1683
## 193               0.02344      0.0000000              0.000000     0.1653
## 494               0.04043      0.0071730              0.011490     0.1613
## 297               0.04721      0.0123600              0.013690     0.1449
## 314               0.05969      0.0136700              0.008907     0.1833
## 141               0.04102      0.0000000              0.000000     0.1903
## 167               0.05736      0.0253100              0.016980     0.1381
## 160               0.03718      0.0030900              0.006588     0.1442
## 308               0.03116      0.0036810              0.003472     0.1788
##      fractal_dimension_mean CV_prediction
## 83                   0.06782 1.00000000000
## 123                  0.06877 1.00000000000
## 181                  0.05770 1.00000000000
## 203                  0.06229 1.00000000000
## 213                  0.05525 1.00000000000
## 340                  0.05506 1.00000000000
## 353                  0.06121 1.00000000000
## 462                  0.05623 1.00000000000
## 522                  0.06739 1.00000000000
## 109                  0.07039 1.00000000000
## 237                  0.06309 1.00000000000
## 565                  0.05623 0.99999999997
## 370                  0.06140 0.99999999991
## 394                  0.06606 0.99999999990
## 568                  0.07016 0.99999999988
## 504                  0.05484 0.99999999987
## 165                  0.05553 0.99999999986
## 564                  0.06879 0.99999999977
## 79                   0.08142 0.99999999976
## 266                  0.05674 0.99999999969
## 251                  0.05898 0.99999999939
## 182                  0.07398 0.99999999913
## 324                  0.06670 0.99999999852
## 273                  0.06194 0.99999999674
## 369                  0.05054 0.99999999572
## 536                  0.06251 0.99999998852
## 303                  0.07469 0.99999997887
## 84                   0.07224 0.99999997806
## 500                  0.06222 0.99999997351
## 450                  0.05661 0.99999997327
## 261                  0.05572 0.99999997041
## 24                   0.05278 0.99999996712
```

```
## 367                  0.06020 0.99999996684
## 566                  0.05533 0.99999996659
## 257                  0.06232 0.99999995330
## 3                     0.05999 0.99999994262
## 130                  0.06113 0.99999993988
## 163                  0.06082 0.99999993953
## 234                  0.05592 0.99999992874
## 433                  0.06053 0.99999991759
## 373                  0.06183 0.99999990289
## 31                   0.06197 0.99999988146
## 534                  0.05419 0.99999979648
## 19                   0.05395 0.99999976508
## 301                  0.06552 0.99999969613
## 220                  0.05313 0.99999969289
## 211                  0.05024 0.99999956874
## 344                  0.05715 0.99999954490
## 452                  0.05391 0.99999954477
## 281                  0.06220 0.99999943523
## 96                   0.05649 0.99999928833
## 390                  0.05884 0.99999928236
## 488                  0.06115 0.99999925796
## 240                  0.05966 0.99999894737
## 374                  0.05478 0.99999882028
## 5                     0.05883 0.99999872748
## 219                  0.05581 0.99999862032
## 253                  0.06697 0.99999801014
## 245                  0.06000 0.99999789715
## 33                   0.06382 0.99999779189
## 13                   0.07800 0.99999773053
## 401                  0.07115 0.99999772570
## 366                  0.05557 0.99999700026
## 518                  0.06188 0.99999659743
## 34                   0.06261 0.99999656024
## 43                   0.06343 0.99999568051
## 322                  0.05096 0.99999395986
## 169                  0.06365 0.99999354396
## 26                   0.07413 0.99999183768
## 434                  0.06132 0.99999079729
## 2                     0.05667 0.99998937819
## 255                  0.05647 0.99998848191
## 238                  0.05177 0.99998798728
## 57                   0.05961 0.99998797876
## 54                   0.06310 0.99998683283
## 447                  0.05916 0.99998152520
## 517                  0.05941 0.99998069242
## 283                  0.05892 0.99998000723
## 259                  0.08104 0.99997983174
## 46                   0.06049 0.99997756814
## 1                     0.07871 0.99996941271
## 157                  0.06166 0.99996399454
```

```
## 88                     0.05629 0.99995667721
## 71                     0.05461 0.99995286353
## 86                     0.06022 0.99994522065
## 260                    0.06650 0.99994424955
## 162                    0.05176 0.99993858070
## 25                     0.06330 0.99993051137
## 28                     0.05699 0.99992164441
## 199                    0.05529 0.99991953769
## 336                    0.06071 0.99990826262
## 563                    0.07152 0.99988920420
## 469                    0.07369 0.99988776925
## 231                    0.06325 0.99988693049
## 122                    0.06213 0.99988139163
## 73                     0.06487 0.99987774121
## 135                    0.05727 0.99986406823
## 352                    0.07603 0.99986104367
## 78                     0.06673 0.99983591949
## 499                    0.06697 0.99982732525
## 409                    0.06069 0.99979659271
## 461                    0.06281 0.99976535790
## 493                    0.06077 0.99972031090
## 128                    0.05044 0.99961825133
## 258                    0.07596 0.99961059388
## 338                    0.06083 0.99960628334
## 119                    0.07331 0.99959702247
## 214                    0.05866 0.99958551032
## 7                      0.05742 0.99956123841
## 371                    0.06218 0.99952823819
## 418                    0.06864 0.99948836064
## 318                    0.05664 0.99948429825
## 263                    0.05464 0.99943931414
## 278                    0.04996 0.99939816853
## 330                    0.06532 0.99917847982
## 18                     0.07356 0.99915021075
## 29                     0.06540 0.99887828864
## 204                    0.07421 0.99866262129
## 329                    0.06277 0.99857139176
## 265                    0.05580 0.99853058583
## 16                     0.07077 0.99839282796
## 510                    0.07083 0.99783273458
## 480                    0.06578 0.99768166390
## 254                    0.05613 0.99736294345
## 275                    0.05510 0.99721627229
## 198                    0.05340 0.99720591319
## 393                    0.06744 0.99683152923
## 442                    0.05407 0.99666720583
## 66                     0.06654 0.99656495681
## 431                    0.06898 0.99557030666
## 178                    0.06323 0.99504008657
## 567                    0.05648 0.99447634746
```

```
## 120                    0.05025 0.99434094121
## 187                    0.05425 0.99424768164
## 202                    0.05491 0.99343353692
## 132                    0.05796 0.99312937483
## 284                    0.06684 0.99263827578
## 36                     0.05656 0.99258910343
## 9                      0.07389 0.99234623841
## 354                    0.06464 0.98916979014
## 30                     0.06149 0.98702501683
## 173                    0.07069 0.98684212974
## 153                    0.09296 0.98601907130
## 63                     0.07292 0.98598395227
## 208                    0.05223 0.98556219063
## 95                     0.06284 0.98326616917
## 133                    0.05891 0.98323616352
## 4                      0.09744 0.98171810882
## 168                    0.05534 0.98153584906
## 195                    0.06672 0.98142429477
## 502                    0.07237 0.98009271887
## 58                     0.06758 0.97789020070
## 35                     0.06515 0.97751027720
## 445                    0.05780 0.97726144551
## 76                     0.05391 0.97678467576
## 118                    0.06768 0.97333860188
## 139                    0.06216 0.97150306669
## 27                     0.06924 0.97108197130
## 10                     0.08243 0.96354420150
## 92                     0.06097 0.95893392770
## 14                     0.05338 0.95862331612
## 15                     0.07682 0.95593996955
## 106                    0.07692 0.95516776246
## 224                    0.06303 0.94737530225
## 23                     0.07032 0.94283962326
## 197                    0.06877 0.93811669410
## 415                    0.05294 0.93692649083
## 262                    0.05307 0.93615482705
## 537                    0.05982 0.92728329818
## 129                    0.06467 0.92417084128
## 191                    0.07542 0.91901499837
## 65                     0.06590 0.90682752367
## 513                    0.07325 0.90024681518
## 142                    0.06248 0.89742386494
## 12                     0.06082 0.89581036386
## 215                    0.06433 0.86565202284
## 276                    0.05875 0.84286318638
## 183                    0.05549 0.82857706240
## 364                    0.05593 0.81495269047
## 230                    0.07254 0.79875787131
## 48                     0.06777 0.79374389828
## 37                     0.06125 0.78740887023
```

```
## 331                    0.05976 0.77991878038
## 8                      0.07451 0.75392274875
## 113                    0.07769 0.74728021198
## 87                     0.05636 0.74681501809
## 542                    0.06341 0.74464120589
## 386                    0.05416 0.74087390312
## 194                    0.06937 0.71021958815
## 90                     0.06346 0.70989762723
## 456                    0.06016 0.70770050288
## 561                    0.06171 0.69852000051
## 17                     0.05922 0.68834952280
## 492                    0.05243 0.68335681614
## 239                    0.06129 0.67206206156
## 200                    0.06466 0.66995909716
## 101                    0.05871 0.65657360311
## 6                      0.07613 0.64519928525
## 158                    0.05268 0.62772090940
## 39                     0.05504 0.62274918995
## 11                     0.05697 0.56879692766
## 436                    0.06544 0.55804366664
## 538                    0.07405 0.53539577891
## 509                    0.05657 0.52813482220
## 100                    0.06390 0.52799091722
## 529                    0.06457 0.52131983776
## 42                     0.06870 0.49725297945
## 376                    0.06572 0.47801049989
## 291                    0.07192 0.47232004641
## 44                     0.06782 0.46885453124
## 543                    0.05680 0.46784538129
## 496                    0.05748 0.45823641194
## 414                    0.05913 0.44920542483
## 55                     0.05684 0.43312207292
## 147                    0.07371 0.42661684490
## 151                    0.06087 0.42327023354
## 134                    0.05723 0.41061096347
## 544                    0.05781 0.37349220515
## 40                     0.06419 0.35480522545
## 77                     0.06641 0.35442737837
## 292                    0.05852 0.33338600741
## 91                     0.05866 0.32831021357
## 256                    0.06130 0.31891374216
## 397                    0.06079 0.31605353634
## 407                    0.05875 0.30300462865
## 490                    0.05325 0.29796648984
## 446                    0.06850 0.29048206931
## 45                     0.06177 0.28072996378
## 457                    0.06166 0.27849718362
## 209                    0.07310 0.27422260835
## 515                    0.05915 0.26139479805
## 454                    0.06121 0.26137909192
```

```
## 357                    0.06501 0.24986263973
## 555                    0.05708 0.24557496379
## 501                    0.06869 0.24513879520
## 185                    0.06317 0.23028982970
## 472                    0.05698 0.23007874737
## 485                    0.06259 0.22864557845
## 127                    0.06130 0.22634491459
## 559                    0.06147 0.20515013221
## 233                    0.05828 0.18251515865
## 422                    0.07406 0.17965264663
## 463                    0.05433 0.17950228130
## 289                    0.06233 0.17202080065
## 112                    0.07070 0.16899500098
## 505                    0.09502 0.16361286451
## 32                     0.07799 0.16126676536
## 69                     0.08046 0.16026234317
## 553                    0.05637 0.15807464368
## 470                    0.07255 0.14591841961
## 149                    0.06081 0.14269671080
## 82                     0.06902 0.14147154507
## 380                    0.07950 0.13426007889
## 170                    0.05650 0.13292543990
## 424                    0.06181 0.13008839684
## 226                    0.05448 0.12653290870
## 50                     0.05718 0.11734412939
## 244                    0.05429 0.11638186500
## 216                    0.06916 0.10961823000
## 264                    0.05443 0.10927871933
## 556                    0.06127 0.10707431826
## 546                    0.05801 0.10501742317
## 458                    0.05584 0.09785326973
## 341                    0.06412 0.09743517315
## 519                    0.07253 0.09512063841
## 206                    0.05986 0.09473789908
## 161                    0.06453 0.08957717362
## 377                    0.08450 0.08837422607
## 453                    0.06104 0.07634275324
## 514                    0.05640 0.07480009078
## 124                    0.06402 0.06960992128
## 560                    0.06570 0.06958240131
## 449                    0.05746 0.06370016629
## 148                    0.06493 0.06223602466
## 201                    0.06013 0.06134694988
## 497                    0.06854 0.05852283986
## 172                    0.05671 0.05472883743
## 205                    0.06373 0.05220410041
## 467                    0.06020 0.05203558763
## 459                    0.05449 0.05063304735
## 378                    0.05763 0.05037142713
## 319                    0.08743 0.04693861893
```

```
## 527                  0.06317 0.04593790571
## 20                   0.05766 0.04557433663
## 477                  0.06009 0.04463559854
## 381                  0.06914 0.04405005906
## 448                  0.05886 0.04399746544
## 166                  0.05266 0.04323399823
## 89                   0.06404 0.04312128384
## 107                  0.06520 0.04222481580
## 249                  0.06329 0.03912168829
## 507                  0.06894 0.03837331962
## 362                  0.05696 0.03769520685
## 74                   0.06566 0.03614252072
## 62                   0.06757 0.03539767863
## 94                   0.05710 0.03493507451
## 524                  0.06843 0.03374856646
## 136                  0.06065 0.03323784841
## 222                  0.06303 0.03225048647
## 280                  0.05853 0.03162702161
## 474                  0.05960 0.03110379523
## 164                  0.06761 0.02983005418
## 228                  0.05907 0.02910193856
## 486                  0.07325 0.02877053293
## 246                  0.06440 0.02836662379
## 484                  0.06088 0.02812348465
## 503                  0.06612 0.02680752282
## 520                  0.06623 0.02633248346
## 423                  0.06320 0.02595251189
## 236                  0.05835 0.02578762652
## 552                  0.06552 0.02545576056
## 487                  0.05355 0.02521993204
## 356                  0.06184 0.02517767864
## 483                  0.06639 0.02502895011
## 81                   0.07005 0.02493958120
## 435                  0.05703 0.02478606590
## 192                  0.06287 0.02350890534
## 241                  0.05660 0.02337118919
## 531                  0.06677 0.02277911666
## 416                  0.06290 0.02270913714
## 41                   0.05587 0.02266039425
## 540                  0.07751 0.02251152806
## 545                  0.06688 0.02144864908
## 395                  0.06161 0.02052168804
## 460                  0.05952 0.02022636089
## 104                  0.06322 0.02014624185
## 114                  0.07782 0.01924043294
## 229                  0.06019 0.01882186776
## 270                  0.06862 0.01878911830
## 332                  0.06540 0.01850967682
## 345                  0.06506 0.01755426041
## 508                  0.07976 0.01746926708
```

```
## 425                    0.07029 0.01742720639
## 506                    0.09575 0.01722561791
## 417                    0.06601 0.01716469004
## 116                    0.06194 0.01715500700
## 300                    0.06556 0.01653002941
## 439                    0.05673 0.01613575872
## 489                    0.06401 0.01555498374
## 140                    0.06072 0.01547349359
## 155                    0.06207 0.01525573608
## 516                    0.06211 0.01500101379
## 473                    0.05669 0.01494760164
## 466                    0.06432 0.01426358691
## 348                    0.05912 0.01406873192
## 512                    0.05348 0.01347705029
## 268                    0.05859 0.01320429542
## 532                    0.06461 0.01276080636
## 152                    0.08261 0.01247591493
## 287                    0.06766 0.01247357915
## 482                    0.05594 0.01241589846
## 97                     0.06635 0.01162950428
## 217                    0.06314 0.01150176307
## 293                    0.06470 0.01099874328
## 21                     0.06811 0.01098201703
## 396                    0.05764 0.01063743538
## 558                    0.06059 0.01055295772
## 428                    0.05977 0.01053959661
## 521                    0.07696 0.01041100381
## 80                     0.05997 0.01039654905
## 398                    0.05750 0.01023662862
## 306                    0.05878 0.00993778130
## 210                    0.05526 0.00975077341
## 70                     0.05653 0.00960020880
## 302                    0.06249 0.00952933917
## 56                     0.05907 0.00946751579
## 38                     0.05863 0.00929009571
## 438                    0.05898 0.00926999184
## 432                    0.07102 0.00911789589
## 410                    0.05597 0.00901061390
## 267                    0.06491 0.00886507177
## 437                    0.06347 0.00855864564
## 232                    0.05628 0.00842004175
## 384                    0.06588 0.00837782946
## 298                    0.06287 0.00812339117
## 243                    0.07669 0.00780831554
## 326                    0.05984 0.00764688341
## 333                    0.06028 0.00744435735
## 321                    0.07279 0.00696648047
## 372                    0.05544 0.00670703535
## 420                    0.06144 0.00662735510
## 363                    0.06183 0.00659837754
```

```
## 550                 0.06328 0.00658025687
## 406                 0.06615 0.00611739998
## 562                 0.05502 0.00610987908
## 408                 0.06114 0.00610658816
## 67                  0.06899 0.00600383011
## 105                 0.06481 0.00588028252
## 269                 0.05769 0.00576844020
## 350                 0.06581 0.00573733723
## 207                 0.06285 0.00566226051
## 188                 0.06095 0.00557386062
## 323                 0.06476 0.00548498155
## 312                 0.05255 0.00541148839
## 412                 0.06340 0.00529892271
## 491                 0.05976 0.00521477181
## 252                 0.05934 0.00515815056
## 476                 0.05913 0.00507405501
## 103                 0.05677 0.00502156221
## 177                 0.08116 0.00495412959
## 554                 0.06576 0.00488180876
## 171                 0.05955 0.00486007932
## 137                 0.05945 0.00485662811
## 290                 0.05955 0.00476208585
## 49                  0.06043 0.00457606492
## 368                 0.05916 0.00444836839
## 225                 0.05674 0.00439279840
## 465                 0.05549 0.00424589375
## 61                  0.06960 0.00423030158
## 375                 0.05669 0.00421012774
## 189                 0.05780 0.00413680301
## 156                 0.06228 0.00413593589
## 248                 0.06409 0.00409542718
## 539                 0.07285 0.00403454355
## 404                 0.06200 0.00400150912
## 250                 0.06168 0.00394077477
## 85                  0.05968 0.00383516688
## 110                 0.06529 0.00383431493
## 455                 0.05826 0.00378073837
## 440                 0.05586 0.00365222974
## 379                 0.05897 0.00360566937
## 51                  0.05888 0.00354813491
## 146                 0.07839 0.00353969699
## 533                 0.06155 0.00352452190
## 144                 0.06235 0.00343889571
## 471                 0.06413 0.00341582856
## 75                  0.05914 0.00340471045
## 339                 0.06331 0.00331402306
## 495                 0.05888 0.00329755162
## 535                 0.06408 0.00325270512
## 143                 0.06562 0.00322673948
## 441                 0.06640 0.00298014333
```

```
## 304                    0.06600 0.00295799940
## 358                    0.05883 0.00294170448
## 285                    0.05935 0.00282664975
## 327                    0.05700 0.00281889883
## 223                    0.06908 0.00281880075
## 196                    0.05667 0.00281342988
## 403                    0.05899 0.00280323674
## 138                    0.05865 0.00280053346
## 343                    0.06907 0.00279564434
## 421                    0.06267 0.00277725915
## 294                    0.05715 0.00275302383
## 383                    0.06659 0.00271563304
## 126                    0.05890 0.00271556342
## 131                    0.06471 0.00265874782
## 557                    0.06331 0.00264587846
## 279                    0.05520 0.00263618211
## 498                    0.06046 0.00260753430
## 150                    0.05580 0.00259790483
## 299                    0.05586 0.00248099783
## 59                     0.05501 0.00245291069
## 400                    0.06019 0.00244884790
## 68                     0.05667 0.00221702181
## 311                    0.06128 0.00221411227
## 530                    0.06608 0.00218617861
## 115                    0.07633 0.00207103324
## 444                    0.05768 0.00203970621
## 411                    0.05913 0.00191747639
## 315                    0.07359 0.00189424096
## 108                    0.06066 0.00186490760
## 360                    0.06959 0.00174990193
## 125                    0.05823 0.00172909278
## 479                    0.06574 0.00161626096
## 385                    0.05594 0.00158136977
## 365                    0.05701 0.00152361119
## 212                    0.06057 0.00148625839
## 478                    0.05536 0.00140600356
## 430                    0.05544 0.00140226243
## 464                    0.05859 0.00139649878
## 53                     0.06110 0.00131769029
## 481                    0.06284 0.00131332947
## 98                     0.06890 0.00130850068
## 541                    0.06782 0.00127871410
## 111                    0.07065 0.00126752942
## 296                    0.05912 0.00120695818
## 221                    0.06344 0.00117311805
## 93                     0.05318 0.00115457571
## 342                    0.07125 0.00114343884
## 451                    0.06612 0.00113008628
## 179                    0.05234 0.00110554143
## 443                    0.05848 0.00106785954
```

```
## 427                   0.06915 0.00106762476
## 335                   0.05945 0.00094384854
## 349                   0.06372 0.00094276102
## 286                   0.05855 0.00092700240
## 475                   0.06837 0.00089536011
## 247                   0.05635 0.00087319759
## 405                   0.05708 0.00086761653
## 174                   0.06669 0.00084843860
## 272                   0.06270 0.00083650881
## 305                   0.06243 0.00081926719
## 313                   0.06140 0.00080310070
## 282                   0.06113 0.00079217342
## 227                   0.06450 0.00078759051
## 548                   0.06714 0.00078097724
## 190                   0.05474 0.00077775597
## 549                   0.06235 0.00075402021
## 392                   0.07098 0.00075169291
## 274                   0.06312 0.00073955349
## 347                   0.06048 0.00073934935
## 389                   0.07252 0.00072968886
## 359                   0.06621 0.00072790233
## 295                   0.06100 0.00072371538
## 361                   0.05185 0.00071275952
## 388                   0.05474 0.00071206280
## 426                   0.06439 0.00070976165
## 218                   0.06315 0.00070963378
## 523                   0.06343 0.00069806059
## 52                    0.05953 0.00069033413
## 102                   0.07818 0.00068546968
## 271                   0.05376 0.00066188955
## 528                   0.05808 0.00064955225
## 320                   0.05561 0.00064416162
## 387                   0.06154 0.00062400631
## 117                   0.07163 0.00056842920
## 154                   0.06105 0.00055412590
## 337                   0.07238 0.00055157250
## 569                   0.05884 0.00054178188
## 547                   0.06201 0.00053289773
## 325                   0.06129 0.00052377050
## 72                    0.08980 0.00051411953
## 99                    0.06582 0.00050110078
## 551                   0.05948 0.00047767588
## 307                   0.05894 0.00046856930
## 184                   0.06217 0.00045066668
## 346                   0.07005 0.00044982297
## 413                   0.06724 0.00044794823
## 159                   0.05907 0.00043303195
## 382                   0.06246 0.00041727141
## 351                   0.05731 0.00039896000
## 525                   0.06891 0.00038944234
```

```
## 22                   0.06905 0.00038607838
## 64                   0.06963 0.00037608776
## 47                   0.06503 0.00037556188
## 277                  0.05821 0.00035953486
## 316                  0.05673 0.00035181279
## 310                  0.05518 0.00032717011
## 468                  0.06412 0.00032085158
## 419                  0.06275 0.00031447074
## 511                  0.06758 0.00031389579
## 526                  0.07126 0.00030923502
## 121                  0.06113 0.00029710032
## 391                  0.06569 0.00029210342
## 429                  0.06148 0.00027926014
## 235                  0.06403 0.00027189802
## 242                  0.05754 0.00025825699
## 186                  0.06048 0.00024860541
## 180                  0.06133 0.00023284878
## 402                  0.05541 0.00020501623
## 328                  0.06070 0.00020291124
## 175                  0.05975 0.00018829244
## 317                  0.05649 0.00013567190
## 334                  0.06081 0.00011243840
## 355                  0.06083 0.00010785200
## 309                  0.05335 0.00009605277
## 176                  0.06724 0.00009239687
## 145                  0.05688 0.00008411288
## 288                  0.05581 0.00007831944
## 399                  0.06214 0.00007612266
## 60                   0.07187 0.00007224763
## 193                  0.06447 0.00006885554
## 494                  0.06013 0.00006254942
## 297                  0.06031 0.00005899537
## 314                  0.06100 0.00005190078
## 141                  0.06422 0.00005071479
## 167                  0.06400 0.00004676403
## 160                  0.05743 0.00002903715
## 308                  0.06833 0.00002302831
```

```r
#dummy variables
xaxis = NULL
cumMean = NULL
cumLift = NULL
meanResponse = mean(Cancer3Final$diagnosis)
meanResponse
```

```
## [1] 0.3725835
```

```r
#initiate variables
xaxis[1] = 1
cumMean[1] = meanResponse
```

```
cumLift[1] = evalOrderedCV$diagnosis[1]

#repeating for all rows
for (i in 2 : nrow(evalOrderedCV)) {
  xaxis[i] = i
  cumMean[i] = cumMean[i-1] + meanResponse
  cumLift[i] = cumLift[i-1] + evalOrderedCV$diagnosis[i]
}

plot(cumMean ~ xaxis)
points(cumLift ~ xaxis)
```
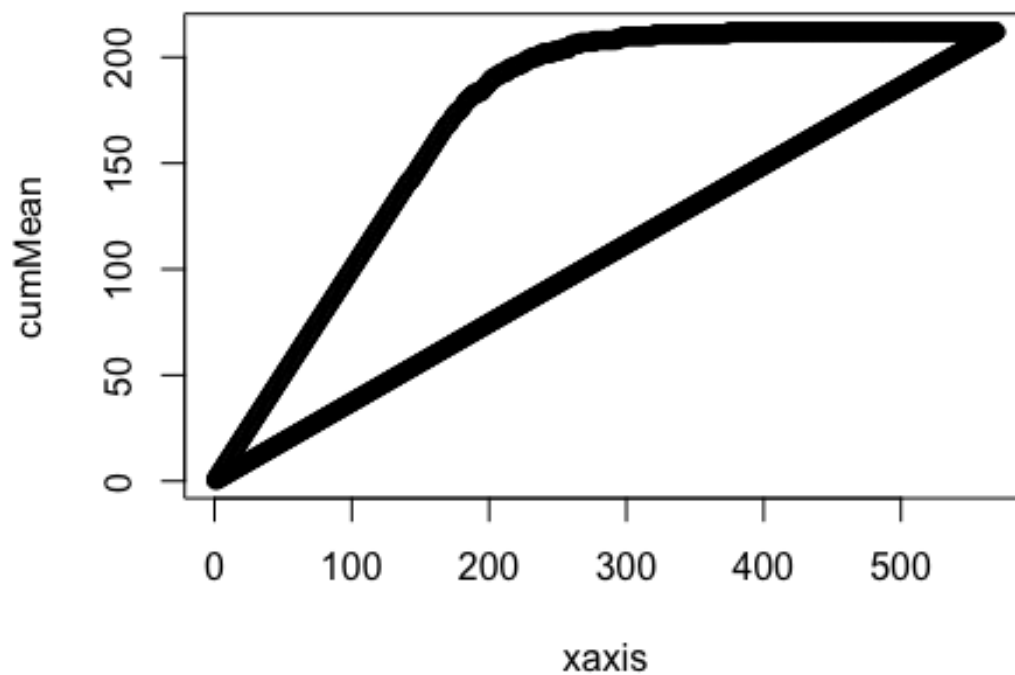


```
## ROC
library(ROCR)
pred_cv = prediction(Cancer3Final$CV_prediction,Cancer3Final$diagnosis)
roc_cv = performance(pred_cv,"sens","fpr")
plot(roc_cv)
```

```
falsePositive = eval[eval$falsePositive==1,]
falseNegative = eval[eval$falseNegative==1,]
falsePositive # This displays it on screen

##      diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 129          0       15.10        16.39          99.58     674.5
0.1150
## 276          0       11.89        17.36          76.20     435.6
0.1225
##      compactness_mean concavity_mean concave.points_mean symmetry_mean
## 129            0.1807        0.11380             0.08534        0.2001
## 276            0.0721        0.05929             0.07404        0.2015
##      fractal_dimension_mean Prediction falsePositive falseNegative
## 129                 0.06467  0.9350541             1             0
## 276                 0.05875  0.7974453             1             0

falseNegative

##      diagnosis radius_mean texture_mean perimeter_mean area_mean
smoothness_mean
## 42           1       10.95        21.35          71.90     371.1
0.12270
## 40           1       13.48        20.82          88.40     559.2
```

```
0.10160
## 172           1           13.43           19.63           85.84      565.4
0.09048
## 298           1           11.76           18.14           75.00      431.1
0.09968
## 45            1           13.17           21.81           85.42      531.5
0.09714
## 206           1           15.12           16.68           98.78      716.6
0.08876
## 380           1           11.08           18.83           73.30      361.6
0.12160
## 127           1           13.61           24.69           87.76      572.6
0.09258
## 41            1           13.44           21.58           86.18      563.0
0.08162
##      compactness_mean concavity_mean concave.points_mean symmetry_mean
## 42            0.12180        0.10440             0.05669        0.1895
## 40            0.12550        0.10630             0.05439        0.1720
## 172           0.06288        0.05858             0.03438        0.1598
## 298           0.05914        0.02685             0.03515        0.1619
## 45            0.10470        0.08259             0.05252        0.1746
## 206           0.09588        0.07550             0.04079        0.1594
## 380           0.21540        0.16890             0.06367        0.2196
## 127           0.07862        0.05285             0.03085        0.1761
## 41            0.06031        0.03110             0.02031        0.1784
##      fractal_dimension_mean  Prediction falsePositive falseNegative
## 42                  0.06870 0.320989574             0             1
## 40                  0.06419 0.251576794             0             1
## 172                 0.05671 0.033414894             0             1
## 298                 0.06287 0.006573481             0             1
## 45                  0.06177 0.277845095             0             1
## 206                 0.05986 0.055791303             0             1
## 380                 0.07950 0.202029928             0             1
## 127                 0.06130 0.160224232             0             1
## 41                  0.05587 0.016167469             0             1

error = (nrow(falseNegative) + nrow(falsePositive))/nrow(eval)
error

## [1] 0.06470588
```

#Linear regression start here

```
###############################################################################
## 1. Initialize and import data
###############################################################################
set.seed(1)
options(scipen = 9999)
library(MASS)
df <- read.csv("/Users/nawwaf/Desktop/Kent/Kent Master_s/Machine
Learning/Final Project/data.csv")
```

```
Cancer3$diagnosis = as.factor(Cancer3$diagnosis) ##automatic
head(df)

##          id diagnosis radius_mean texture_mean perimeter_mean area_mean
## 1   842302         M       17.99        10.38         122.80    1001.0
## 2   842517         M       20.57        17.77         132.90    1326.0
## 3 84300903         M       19.69        21.25         130.00    1203.0
## 4 84348301         M       11.42        20.38          77.58     386.1
## 5 84358402         M       20.29        14.34         135.10    1297.0
## 6   843786         M       12.45        15.70          82.57     477.1
##   smoothness_mean compactness_mean concavity_mean concave.points_mean
## 1         0.11840          0.27760         0.3001             0.14710
## 2         0.08474          0.07864         0.0869             0.07017
## 3         0.10960          0.15990         0.1974             0.12790
## 4         0.14250          0.28390         0.2414             0.10520
## 5         0.10030          0.13280         0.1980             0.10430
## 6         0.12780          0.17000         0.1578             0.08089
##   symmetry_mean fractal_dimension_mean radius_se texture_se perimeter_se
## 1        0.2419                0.07871    1.0950     0.9053        8.589
## 2        0.1812                0.05667    0.5435     0.7339        3.398
## 3        0.2069                0.05999    0.7456     0.7869        4.585
## 4        0.2597                0.09744    0.4956     1.1560        3.445
## 5        0.1809                0.05883    0.7572     0.7813        5.438
## 6        0.2087                0.07613    0.3345     0.8902        2.217
##   area_se smoothness_se compactness_se concavity_se concave.points_se
## 1  153.40      0.006399        0.04904      0.05373           0.01587
## 2   74.08      0.005225        0.01308      0.01860           0.01340
## 3   94.03      0.006150        0.04006      0.03832           0.02058
## 4   27.23      0.009110        0.07458      0.05661           0.01867
## 5   94.44      0.011490        0.02461      0.05688           0.01885
## 6   27.19      0.007510        0.03345      0.03672           0.01137
##   symmetry_se fractal_dimension_se radius_worst texture_worst
perimeter_worst
## 1     0.03003             0.006193        25.38         17.33
184.60
## 2     0.01389             0.003532        24.99         23.41
158.80
## 3     0.02250             0.004571        23.57         25.53
152.50
## 4     0.05963             0.009208        14.91         26.50
98.87
## 5     0.01756             0.005115        22.54         16.67
152.20
## 6     0.02165             0.005082        15.47         23.75
103.40
##   area_worst smoothness_worst compactness_worst concavity_worst
## 1     2019.0           0.1622            0.6656          0.7119
## 2     1956.0           0.1238            0.1866          0.2416
## 3     1709.0           0.1444            0.4245          0.4504
```

```
## 4      567.7            0.2098           0.8663         0.6869
## 5     1575.0            0.1374           0.2050         0.4000
## 6      741.6            0.1791           0.5249         0.5355
##    concave.points_worst symmetry_worst fractal_dimension_worst  X
## 1               0.2654         0.4601                 0.11890 NA
## 2               0.1860         0.2750                 0.08902 NA
## 3               0.2430         0.3613                 0.08758 NA
## 4               0.2575         0.6638                 0.17300 NA
## 5               0.1625         0.2364                 0.07678 NA
## 6               0.1741         0.3985                 0.12440 NA

df <- df[,-33]

head(df)

##        id diagnosis radius_mean texture_mean perimeter_mean area_mean
## 1   842302         M       17.99        10.38         122.80    1001.0
## 2   842517         M       20.57        17.77         132.90    1326.0
## 3 84300903         M       19.69        21.25         130.00    1203.0
## 4 84348301         M       11.42        20.38          77.58     386.1
## 5 84358402         M       20.29        14.34         135.10    1297.0
## 6   843786         M       12.45        15.70          82.57     477.1
##    smoothness_mean compactness_mean concavity_mean concave.points_mean
## 1          0.11840          0.27760         0.3001             0.14710
## 2          0.08474          0.07864         0.0869             0.07017
## 3          0.10960          0.15990         0.1974             0.12790
## 4          0.14250          0.28390         0.2414             0.10520
## 5          0.10030          0.13280         0.1980             0.10430
## 6          0.12780          0.17000         0.1578             0.08089
##    symmetry_mean fractal_dimension_mean radius_se texture_se perimeter_se
## 1         0.2419                0.07871    1.0950     0.9053        8.589
## 2         0.1812                0.05667    0.5435     0.7339        3.398
## 3         0.2069                0.05999    0.7456     0.7869        4.585
## 4         0.2597                0.09744    0.4956     1.1560        3.445
## 5         0.1809                0.05883    0.7572     0.7813        5.438
## 6         0.2087                0.07613    0.3345     0.8902        2.217
##    area_se smoothness_se compactness_se concavity_se concave.points_se
## 1  153.40      0.006399        0.04904      0.05373           0.01587
## 2   74.08      0.005225        0.01308      0.01860           0.01340
## 3   94.03      0.006150        0.04006      0.03832           0.02058
## 4   27.23      0.009110        0.07458      0.05661           0.01867
## 5   94.44      0.011490        0.02461      0.05688           0.01885
## 6   27.19      0.007510        0.03345      0.03672           0.01137
##    symmetry_se fractal_dimension_se radius_worst texture_worst
perimeter_worst
## 1     0.03003             0.006193        25.38         17.33
184.60
## 2     0.01389             0.003532        24.99         23.41
158.80
## 3     0.02250             0.004571        23.57         25.53
```

```
152.50
## 4     0.05963              0.009208         14.91         26.50
98.87
## 5     0.01756              0.005115         22.54         16.67
152.20
## 6     0.02165              0.005082         15.47         23.75
103.40
##   area_worst smoothness_worst compactness_worst concavity_worst
## 1     2019.0          0.1622            0.6656          0.7119
## 2     1956.0          0.1238            0.1866          0.2416
## 3     1709.0          0.1444            0.4245          0.4504
## 4      567.7          0.2098            0.8663          0.6869
## 5     1575.0          0.1374            0.2050          0.4000
## 6      741.6          0.1791            0.5249          0.5355
##   concave.points_worst symmetry_worst fractal_dimension_worst
## 1               0.2654         0.4601                 0.11890
## 2               0.1860         0.2750                 0.08902
## 3               0.2430         0.3613                 0.08758
## 4               0.2575         0.6638                 0.17300
## 5               0.1625         0.2364                 0.07678
## 6               0.1741         0.3985                 0.12440
```

```
df <- df[,-1]
#df <- na.omit(df) # Remove NA (missing) values

summary(df)
```

```
##   diagnosis          radius_mean     texture_mean    perimeter_mean
## Length:569         Min.   : 6.981   Min.   : 9.71   Min.   : 43.79
## Class :character   1st Qu.:11.700   1st Qu.:16.17   1st Qu.: 75.17
## Mode  :character   Median :13.370   Median :18.84   Median : 86.24
##                    Mean   :14.127   Mean   :19.29   Mean   : 91.97
##                    3rd Qu.:15.780   3rd Qu.:21.80   3rd Qu.:104.10
##                    Max.   :28.110   Max.   :39.28   Max.   :188.50
##   area_mean       smoothness_mean   compactness_mean  concavity_mean
## Min.   : 143.5   Min.   :0.05263   Min.   :0.01938   Min.   :0.00000
## 1st Qu.: 420.3   1st Qu.:0.08637   1st Qu.:0.06492   1st Qu.:0.02956
## Median : 551.1   Median :0.09587   Median :0.09263   Median :0.06154
## Mean   : 654.9   Mean   :0.09636   Mean   :0.10434   Mean   :0.08880
## 3rd Qu.: 782.7   3rd Qu.:0.10530   3rd Qu.:0.13040   3rd Qu.:0.13070
## Max.   :2501.0   Max.   :0.16340   Max.   :0.34540   Max.   :0.42680
##   concave.points_mean symmetry_mean    fractal_dimension_mean   radius_se
## Min.   :0.00000     Min.   :0.1060   Min.   :0.04996        Min.
## :0.1115
## 1st Qu.:0.02031     1st Qu.:0.1619   1st Qu.:0.05770        1st
## Qu.:0.2324
## Median :0.03350     Median :0.1792   Median :0.06154        Median
## :0.3242
## Mean   :0.04892     Mean   :0.1812   Mean   :0.06280        Mean
## :0.4052
```

```
## 3rd Qu.:0.07400      3rd Qu.:0.1957   3rd Qu.:0.06612         3rd
Qu.:0.4789
## Max.    :0.20120      Max.    :0.3040   Max.    :0.09744        Max.
:2.8730
##    texture_se       perimeter_se       area_se        smoothness_se
## Min.    :0.3602   Min.    : 0.757   Min.    : 6.802   Min.    :0.001713
## 1st Qu.:0.8339   1st Qu.: 1.606   1st Qu.: 17.850   1st Qu.:0.005169
## Median :1.1080   Median : 2.287   Median : 24.530   Median :0.006380
## Mean    :1.2169   Mean    : 2.866   Mean    : 40.337   Mean    :0.007041
## 3rd Qu.:1.4740   3rd Qu.: 3.357   3rd Qu.: 45.190   3rd Qu.:0.008146
## Max.    :4.8850   Max.    :21.980   Max.    :542.200   Max.    :0.031130
## compactness_se      concavity_se      concave.points_se   symmetry_se
## Min.    :0.002252   Min.    :0.00000   Min.    :0.000000   Min.    :0.007882
## 1st Qu.:0.013080   1st Qu.:0.01509   1st Qu.:0.007638   1st Qu.:0.015160
## Median :0.020450   Median :0.02589   Median :0.010930   Median :0.018730
## Mean    :0.025478   Mean    :0.03189   Mean    :0.011796   Mean    :0.020542
## 3rd Qu.:0.032450   3rd Qu.:0.04205   3rd Qu.:0.014710   3rd Qu.:0.023480
## Max.    :0.135400   Max.    :0.39600   Max.    :0.052790   Max.    :0.078950
## fractal_dimension_se  radius_worst     texture_worst    perimeter_worst
## Min.    :0.0008948   Min.    : 7.93   Min.    :12.02   Min.    : 50.41
## 1st Qu.:0.0022480   1st Qu.:13.01   1st Qu.:21.08   1st Qu.: 84.11
## Median :0.0031870   Median :14.97   Median :25.41   Median : 97.66
## Mean    :0.0037949   Mean    :16.27   Mean    :25.68   Mean    :107.26
## 3rd Qu.:0.0045580   3rd Qu.:18.79   3rd Qu.:29.72   3rd Qu.:125.40
## Max.    :0.0298400   Max.    :36.04   Max.    :49.54   Max.    :251.20
##    area_worst       smoothness_worst  compactness_worst concavity_worst
## Min.    : 185.2   Min.    :0.07117   Min.    :0.02729   Min.    :0.0000
## 1st Qu.: 515.3   1st Qu.:0.11660   1st Qu.:0.14720   1st Qu.:0.1145
## Median : 686.5   Median :0.13130   Median :0.21190   Median :0.2267
## Mean    : 880.6   Mean    :0.13237   Mean    :0.25427   Mean    :0.2722
## 3rd Qu.:1084.0   3rd Qu.:0.14600   3rd Qu.:0.33910   3rd Qu.:0.3829
## Max.    :4254.0   Max.    :0.22260   Max.    :1.05800   Max.    :1.2520
## concave.points_worst symmetry_worst   fractal_dimension_worst
## Min.    :0.00000     Min.    :0.1565   Min.    :0.05504
## 1st Qu.:0.06493     1st Qu.:0.2504   1st Qu.:0.07146
## Median :0.09993     Median :0.2822   Median :0.08004
## Mean    :0.11461     Mean    :0.2901   Mean    :0.08395
## 3rd Qu.:0.16140     3rd Qu.:0.3179   3rd Qu.:0.09208
## Max.    :0.29100     Max.    :0.6638   Max.    :0.20750

################################################################################
## 2. Split the data in training and evaluating set (70%-30%)
################################################################################

s = sample(length(df$diagnosis), floor(length(df$diagnosis)*0.7))
s

##   [1] 129 509 471 299 270 187 307 277 494 330  37 105 485 382 326 560 422
111
##  [19] 404 532 506 343 121  40 537 375 248 198 378  39 435 390 280 526  45
```

```
402
## [37]   22 193 371 499 104 555 492 465 525 176 345 110  84  29 141 252 304
287
## [55] 145 329 487 548 339 118 498 346 517 107  64 478 490 224 103 316  51
221
## [73] 290 138 569 566 443 282 143 442 285 408 170  48 204 295  24 181 476
214
## [91] 296 225 511 508 163  43   1 520  78 406 528 284 116 233 293  61 430
369
## [109] 451  86 327 522 355 563 300  49 361 500 242 440 246 305 306 247 239
219
## [127] 135 552  20 377 488 530  53 400 356 130 507  65 455 359 558 124  77
218
## [145]  98 194  19 273 418  31 419 457 174 403 237  75  16 546 265 447  92
122
## [163] 152 496 207 249 160 229 140 126  14 467 413 271 434 432 358 553 212
127
## [181] 133  41 364 373 328  36 448 297 505 495 309 391 362 344 117 379 102
50
## [199] 336 286 254 349  72 567 168 385 398 539 113 234 547  73  27 388  15
294
## [217]  62 132  35 427 429 185 459 153 420 559 255 231  28 353 148 489 538
298
## [235]  60 468 523 268  93 431 202 425 527 241  33 352 544 460 217 545 536
108
## [253] 396 565 445 209  97 502 367 437  56 342 199 256 201 414   2 363 131
466
## [271] 317 156 197 220 235 473 173  83 208 444 348 501 253 180 162 568 475
167
## [289] 454 190 161 519 446 534 338 374  25  81 222 203 529   3 179 147 279
337
## [307] 260 205 335 482 389 106 351 463  23 157 323 257 164 383 119  99 283
477
## [325] 150 410 169 322 211 318  18  44 347 472  91 251  32 223 438 551 314
308
## [343] 125 370  89 250 149  21  79 115 101 192 216 366  71 128  59  90 158
58
## [361] 421 114 381 134  34 561 354  17 340 516 535 365  66 450 244 136 392
449
## [379] 439   5  74 441 183 274 334 462 303 380 261  69 210 412 278 550 324
42
## [397] 123 259

train = df[s,]
eval = df[-s,]

###############################################################################
## 3. Run a standard linear regression model on the radius_mean of tumor
(radius_mean)
###############################################################################
```

```
reg = lm(train$radius_mean~.,data=train)
reg
```

```
##
## Call:
## lm(formula = train$radius_mean ~ ., data = train)
##
## Coefficients:
##             (Intercept)               diagnosisM              texture_mean
##               0.4606835               -0.0137459                 0.0006519
##          perimeter_mean                area_mean            smoothness_mean
##               0.1365224                0.0007367                 1.3821097
##        compactness_mean           concavity_mean        concave.points_mean
##              -3.8591198               -1.7216037                 0.5914781
##           symmetry_mean    fractal_dimension_mean                 radius_se
##               0.2746640                2.0976799                 0.1718394
##               texture_se             perimeter_se                   area_se
##               0.0217702               -0.0474092                 0.0001944
##           smoothness_se           compactness_se               concavity_se
##               0.9108659               -0.9559376                 0.9561953
##        concave.points_se              symmetry_se      fractal_dimension_se
##               3.7520342               -0.9726007                 4.1570796
##            radius_worst            texture_worst            perimeter_worst
##               0.1403176               -0.0027180                -0.0079314
##              area_worst          smoothness_worst          compactness_worst
##              -0.0005058               -0.7453486                 0.3788198
##          concavity_worst      concave.points_worst             symmetry_worst
##               0.0697517               -0.0377612                -0.0818514
## fractal_dimension_worst
##              -1.1535704
```

```
summary(reg)
```

```
##
## Call:
## lm(formula = train$radius_mean ~ ., data = train)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.287012 -0.029219  0.000602  0.025323  0.225395
##
## Coefficients:
##                         Estimate Std. Error t value              Pr(>|t|)
## (Intercept)            0.4606835  0.1228599   3.750              0.000206
***
## diagnosisM            -0.0137459  0.0128775  -1.067              0.286477
## texture_mean           0.0006519  0.0024728   0.264              0.792207
## perimeter_mean         0.1365224  0.0030434  44.858 < 0.0000000000000002
***
## area_mean              0.0007367  0.0001655   4.452   0.0000112872471560
```

```
***
## smoothness_mean          1.3821097   0.5738891    2.408               0.016518
*
## compactness_mean        -3.8591198   0.3380225  -11.417 < 0.0000000000000002
***
## concavity_mean          -1.7216037   0.3062194   -5.622   0.0000000374043744
***
## concave.points_mean      0.5914781   0.5940163    0.996               0.320039
## symmetry_mean            0.2746640   0.2197782    1.250               0.212194
## fractal_dimension_mean   2.0976799   1.6023851    1.309               0.191320
## radius_se                0.1718394   0.1094082    1.571               0.117131
## texture_se               0.0217702   0.0110654    1.967               0.049889
*
## perimeter_se            -0.0474092   0.0145597   -3.256               0.001234
**
## area_se                  0.0001944   0.0004163    0.467               0.640694
## smoothness_se            0.9108659   1.9749130    0.461               0.644915
## compactness_se          -0.9559376   0.7194185   -1.329               0.184751
## concavity_se             0.9561953   0.3722864    2.568               0.010611
*
## concave.points_se        3.7520342   1.6079300    2.333               0.020164
*
## symmetry_se             -0.9726007   0.7907682   -1.230               0.219506
## fractal_dimension_se     4.1570796   3.6439049    1.141               0.254684
## radius_worst             0.1403176   0.0180395    7.778   0.0000000000000752
***
## texture_worst           -0.0027180   0.0021562   -1.261               0.208269
## perimeter_worst         -0.0079314   0.0018784   -4.223   0.0000305009984407
***
## area_worst              -0.0005058   0.0001059   -4.777   0.0000025810899927
***
## smoothness_worst        -0.7453486   0.4166172   -1.789               0.074431
.
## compactness_worst        0.3788198   0.1131446    3.348               0.000898
***
## concavity_worst          0.0697517   0.0778701    0.896               0.370976
## concave.points_worst    -0.0377612   0.2693871   -0.140               0.888599
## symmetry_worst          -0.0818514   0.1410668   -0.580               0.562115
## fractal_dimension_worst -1.1535704   0.7114395   -1.621               0.105778
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.05714 on 367 degrees of freedom
## Multiple R-squared:  0.9998, Adjusted R-squared:  0.9997
## F-statistic: 5.264e+04 on 30 and 367 DF,  p-value: < 0.00000000000000022
```

Task 5. predictions and test the quality of the model

```
predict = predict(reg, eval)
predict
```

```
##        4        6        7        8        9       10       11
12
## 11.258443 12.455825 18.279689 13.699955 13.008323 12.416709 15.957941
15.876853
##       13       26       30       38       46       47       52
54
## 19.331615 17.185624 17.547557 13.036548 18.677496  8.212742 13.600788
18.148217
##       55       57       63       67       68       70       76
80
## 15.101735 19.169047 14.323034  9.432796 11.291802 12.746291 16.071511
12.882061
##       82       85       87       88       94       95       96
100
## 13.304931 12.043227 14.427302 18.826697 13.458326 15.132697 20.210401
14.451792
##      109      112      120      137      139      142      144
146
## 22.167256 12.560633 17.704484 11.754559 14.762580 16.127280 12.907333
11.980102
##      151      154      155      159      165      166      171
172
## 13.024770 11.180371 13.141122 12.079941 23.241561 14.908716 12.341570
13.443493
##      175      177      178      182      184      186      188
189
## 10.679539  9.930216 16.427082 21.075127 11.481954 10.110439 11.706105
11.821634
##      191      195      196      200      206      213      215
226
## 13.946580 14.792518 12.901295 14.476691 15.185573 28.015965 14.106910
14.363420
##      227      228      230      232      236      238      240
243
## 10.457696 14.941748 12.732410 11.286864 14.009496 20.403433 17.419691
11.222725
##      245      258      262      263      264      266      267
269
## 19.377072 15.222748 17.254746 17.398894 15.584945 20.554350 10.626638
12.869312
##      272      275      276      281      288      289      291
292
## 11.305167 17.855913 11.918578 19.029649 12.874824 11.348666 14.567051
14.920800
##      301      302      310      311      312      313      315
319
## 19.538953 12.390683 13.050941 11.693095 14.597486 12.814408  8.581425
8.837469
##      320      321      325      331      332      333      341
350
```

```
## 12.414510 10.334880 12.189118 16.120923 12.928873 11.243642 14.464112
11.909830
##       357      360      368      372      376      384      386
387
## 12.995098  9.533507 12.221893 15.176114 16.164202 12.366149 14.554218
12.210152
##       393      394      395      397      399      401      405
407
## 15.478021 21.562568 12.082324 13.529300 11.122796 18.074984 12.310115
16.133232
##       409      411      415      416      417      423      424
426
## 17.996711 11.383372 15.081545 11.893859  9.453092 11.604913 13.695094
10.051740
##       428      433      436      452      453      456      458
461
## 10.847864 20.189704 13.961869 19.519699 11.983722 13.421428 13.168375
17.016845
##       464      469      470      474      479      480      481
483
## 11.570747 17.776915 11.632106 12.225413 11.497922 16.282985 12.163525
13.445316
##       484      486      491      493      497      503      504
510
## 13.650102 12.426724 12.267783 18.006102 12.640492 12.533122 23.056426
15.433387
##       512      513      514      515      518      521      524
531
## 14.768120 13.378432 14.585072 15.040180 19.877391  9.307927 13.662207
11.759515
##       533      540      541      542      543      549      554
556
## 13.712274  7.492166 11.542220 14.536397 14.724631  9.689779  9.331060
10.266371
##       557      562      564
## 10.160189 11.175933 20.891053

me = mean(eval$radius_mean-predict)
me

## [1] 0.01130962

rmse = sqrt(mean((eval$radius_mean-predict)**2))
rmse

## [1] 0.06690827

mape = mean(abs(eval$radius_mean-predict)/eval$radius_mean)*100
mape

## [1] 0.3261073
```

```
################################################################################
## 4. Investigate reducing complexity by dropping variables
################################################################################

drop1(reg)

## Single term deletions
##
## Model:
## train$radius_mean ~ diagnosis + texture_mean + perimeter_mean +
##      area_mean + smoothness_mean + compactness_mean + concavity_mean +
##      concave.points_mean + symmetry_mean + fractal_dimension_mean +
##      radius_se + texture_se + perimeter_se + area_se + smoothness_se +
##      compactness_se + concavity_se + concave.points_se + symmetry_se +
##      fractal_dimension_se + radius_worst + texture_worst + perimeter_worst
+
##      area_worst + smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst
##                         Df Sum of Sq    RSS      AIC
## <none>                                1.1983 -2248.6
## diagnosis                1    0.0037 1.2020 -2249.4
## texture_mean             1    0.0002 1.1985 -2250.6
## perimeter_mean           1    6.5699 7.7682 -1506.7
## area_mean                1    0.0647 1.2630 -2229.7
## smoothness_mean          1    0.0189 1.2172 -2244.4
## compactness_mean         1    0.4256 1.6238 -2129.7
## concavity_mean           1    0.1032 1.3015 -2217.7
## concave.points_mean      1    0.0032 1.2015 -2249.6
## symmetry_mean            1    0.0051 1.2033 -2248.9
## fractal_dimension_mean   1    0.0056 1.2038 -2248.8
## radius_se                1    0.0081 1.2063 -2248.0
## texture_se               1    0.0126 1.2109 -2246.4
## perimeter_se             1    0.0346 1.2329 -2239.3
## area_se                  1    0.0007 1.1990 -2250.4
## smoothness_se            1    0.0007 1.1989 -2250.4
## compactness_se           1    0.0058 1.2040 -2248.7
## concavity_se             1    0.0215 1.2198 -2243.5
## concave.points_se        1    0.0178 1.2160 -2244.8
## symmetry_se              1    0.0049 1.2032 -2249.0
## fractal_dimension_se     1    0.0042 1.2025 -2249.2
## radius_worst             1    0.1975 1.3958 -2189.9
## texture_worst            1    0.0052 1.2034 -2248.9
## perimeter_worst          1    0.0582 1.2565 -2231.7
## area_worst               1    0.0745 1.2727 -2226.6
## smoothness_worst         1    0.0105 1.2087 -2247.2
## compactness_worst        1    0.0366 1.2349 -2238.7
## concavity_worst          1    0.0026 1.2009 -2249.8
## concave.points_worst     1    0.0001 1.1983 -2250.6
## symmetry_worst           1    0.0011 1.1993 -2250.3
## fractal_dimension_worst  1    0.0086 1.2068 -2247.8
```

```
reg1 = lm(radius_mean~.-texture_mean, data=train)
drop1(reg1)

## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
##      smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##      texture_mean
##                          Df Sum of Sq    RSS      AIC
## <none>                                 1.1985 -2250.6
## diagnosis                 1    0.0036 1.2021 -2251.3
## perimeter_mean            1    6.8213 8.0198 -1496.0
## area_mean                 1    0.0647 1.2631 -2231.6
## smoothness_mean           1    0.0193 1.2178 -2246.2
## compactness_mean          1    0.4272 1.6256 -2131.2
## concavity_mean            1    0.1042 1.3027 -2219.4
## concave.points_mean       1    0.0033 1.2018 -2251.4
## symmetry_mean             1    0.0054 1.2039 -2250.8
## fractal_dimension_mean    1    0.0056 1.2041 -2250.7
## radius_se                 1    0.0089 1.2074 -2249.6
## texture_se                1    0.0155 1.2140 -2247.4
## perimeter_se              1    0.0349 1.2333 -2241.1
## area_se                   1    0.0006 1.1991 -2252.3
## smoothness_se             1    0.0008 1.1993 -2252.3
## compactness_se            1    0.0058 1.2043 -2250.6
## concavity_se              1    0.0216 1.2201 -2245.4
## concave.points_se         1    0.0179 1.2164 -2246.7
## symmetry_se               1    0.0047 1.2032 -2251.0
## fractal_dimension_se      1    0.0042 1.2027 -2251.2
## radius_worst              1    0.2016 1.4001 -2190.7
## texture_worst             1    0.0261 1.2246 -2244.0
## perimeter_worst           1    0.0583 1.2568 -2233.7
## area_worst                1    0.0749 1.2734 -2228.4
## smoothness_worst          1    0.0114 1.2099 -2248.8
## compactness_worst         1    0.0368 1.2353 -2240.5
## concavity_worst           1    0.0027 1.2012 -2251.7
## concave.points_worst      1    0.0001 1.1986 -2252.5
## symmetry_worst            1    0.0015 1.2000 -2252.1
## fractal_dimension_worst   1    0.0085 1.2069 -2249.8
```

```
reg2 = lm(radius_mean~.-texture_mean-concave.points_worst, data=train)
drop1(reg2)

## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
##      smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##      texture_mean - concave.points_worst
##                         Df Sum of Sq    RSS      AIC
## <none>                               1.1986 -2252.5
## diagnosis                1     0.0037 1.2022 -2253.3
## perimeter_mean           1     6.9624 8.1610 -1491.1
## area_mean                1     0.0647 1.2633 -2233.6
## smoothness_mean          1     0.0221 1.2207 -2247.2
## compactness_mean         1     0.4296 1.6281 -2132.6
## concavity_mean           1     0.1091 1.3076 -2219.8
## concave.points_mean      1     0.0039 1.2024 -2253.2
## symmetry_mean            1     0.0055 1.2040 -2252.7
## fractal_dimension_mean   1     0.0056 1.2042 -2252.7
## radius_se                1     0.0091 1.2077 -2251.5
## texture_se               1     0.0155 1.2140 -2249.4
## perimeter_se             1     0.0348 1.2334 -2243.1
## area_se                  1     0.0005 1.1991 -2254.3
## smoothness_se            1     0.0010 1.1996 -2254.2
## compactness_se           1     0.0057 1.2043 -2252.6
## concavity_se             1     0.0224 1.2209 -2247.2
## concave.points_se        1     0.0266 1.2252 -2245.8
## symmetry_se              1     0.0047 1.2032 -2253.0
## fractal_dimension_se     1     0.0042 1.2028 -2253.1
## radius_worst             1     0.2022 1.4007 -2192.5
## texture_worst            1     0.0260 1.2246 -2246.0
## perimeter_worst          1     0.0594 1.2580 -2235.3
## area_worst               1     0.0753 1.2738 -2230.3
## smoothness_worst         1     0.0137 1.2123 -2250.0
## compactness_worst        1     0.0367 1.2353 -2242.5
## concavity_worst          1     0.0028 1.2013 -2253.6
## symmetry_worst           1     0.0016 1.2002 -2254.0
## fractal_dimension_worst  1     0.0084 1.2070 -2251.7
```

```
reg3 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se,
data=train)
drop1(reg3)

## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
##      smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##      texture_mean - concave.points_worst - area_se
##                         Df Sum of Sq     RSS      AIC
## <none>                                1.1991 -2254.3
## diagnosis                 1     0.0038  1.2029 -2255.1
## perimeter_mean            1     9.0541 10.2532 -1402.2
## area_mean                 1     0.0702  1.2693 -2233.7
## smoothness_mean           1     0.0224  1.2215 -2249.0
## compactness_mean          1     0.4411  1.6403 -2131.7
## concavity_mean            1     0.1086  1.3077 -2221.8
## concave.points_mean       1     0.0036  1.2027 -2255.1
## symmetry_mean             1     0.0051  1.2042 -2254.7
## fractal_dimension_mean    1     0.0053  1.2044 -2254.6
## radius_se                 1     0.0140  1.2131 -2251.7
## texture_se                1     0.0150  1.2141 -2251.4
## perimeter_se              1     0.0343  1.2334 -2245.1
## smoothness_se             1     0.0009  1.2000 -2256.1
## compactness_se            1     0.0054  1.2045 -2254.6
## concavity_se              1     0.0224  1.2215 -2249.0
## concave.points_se         1     0.0263  1.2254 -2247.7
## symmetry_se               1     0.0057  1.2048 -2254.5
## fractal_dimension_se      1     0.0039  1.2030 -2255.1
## radius_worst              1     0.2536  1.4527 -2180.0
## texture_worst             1     0.0258  1.2249 -2247.9
## perimeter_worst           1     0.0607  1.2598 -2236.7
## area_worst                1     0.1164  1.3155 -2219.5
## smoothness_worst          1     0.0133  1.2124 -2252.0
## compactness_worst         1     0.0364  1.2355 -2244.4
## concavity_worst           1     0.0026  1.2017 -2255.5
## symmetry_worst            1     0.0013  1.2004 -2255.9
## fractal_dimension_worst   1     0.0080  1.2071 -2253.7
```

```
reg4 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se, data=train)
drop1(reg4)

## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
##      smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##      texture_mean - concave.points_worst - area_se - smoothness_se
##                        Df Sum of Sq      RSS      AIC
## <none>                                1.2000 -2256.1
## diagnosis               1     0.0034  1.2034 -2256.9
## perimeter_mean          1     9.0623 10.2623 -1403.9
## area_mean               1     0.0718  1.2718 -2234.9
## smoothness_mean         1     0.0216  1.2216 -2251.0
## compactness_mean        1     0.4412  1.6412 -2133.4
## concavity_mean          1     0.1078  1.3078 -2223.8
## concave.points_mean     1     0.0032  1.2032 -2257.0
## symmetry_mean           1     0.0055  1.2055 -2256.2
## fractal_dimension_mean  1     0.0054  1.2054 -2256.3
## radius_se               1     0.0156  1.2156 -2252.9
## texture_se              1     0.0153  1.2153 -2253.0
## perimeter_se            1     0.0370  1.2370 -2245.9
## compactness_se          1     0.0045  1.2045 -2256.6
## concavity_se            1     0.0215  1.2215 -2251.0
## concave.points_se       1     0.0287  1.2287 -2248.6
## symmetry_se             1     0.0049  1.2049 -2256.4
## fractal_dimension_se    1     0.0040  1.2040 -2256.7
## radius_worst            1     0.2539  1.4539 -2181.7
## texture_worst           1     0.0259  1.2259 -2249.5
## perimeter_worst         1     0.0598  1.2598 -2238.7
## area_worst              1     0.1170  1.3170 -2221.0
## smoothness_worst        1     0.0152  1.2151 -2253.1
## compactness_worst       1     0.0357  1.2357 -2246.4
## concavity_worst         1     0.0024  1.2024 -2257.3
## symmetry_worst          1     0.0019  1.2018 -2257.4
## fractal_dimension_worst 1     0.0082  1.2081 -2255.3

reg5 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst, data=train)
drop1(reg5)
```

```
## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
##      smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##      texture_mean - concave.points_worst - area_se - smoothness_se -
##      symmetry_worst
##                        Df Sum of Sq      RSS      AIC
## <none>                             1.2018 -2257.4
## diagnosis               1    0.0036  1.2054 -2258.2
## perimeter_mean          1    9.2161 10.4180 -1399.9
## area_mean               1    0.0708  1.2726 -2236.7
## smoothness_mean         1    0.0226  1.2244 -2252.0
## compactness_mean        1    0.4397  1.6415 -2135.3
## concavity_mean          1    0.1064  1.3082 -2225.7
## concave.points_mean     1    0.0029  1.2048 -2258.5
## symmetry_mean           1    0.0037  1.2056 -2258.2
## fractal_dimension_mean  1    0.0054  1.2073 -2257.6
## radius_se               1    0.0165  1.2183 -2254.0
## texture_se              1    0.0203  1.2222 -2252.8
## perimeter_se            1    0.0370  1.2388 -2247.4
## compactness_se          1    0.0037  1.2055 -2258.2
## concavity_se            1    0.0199  1.2217 -2252.9
## concave.points_se       1    0.0312  1.2330 -2249.2
## symmetry_se             1    0.0183  1.2202 -2253.4
## fractal_dimension_se    1    0.0045  1.2064 -2257.9
## radius_worst            1    0.2521  1.4539 -2183.7
## texture_worst           1    0.0291  1.2310 -2249.9
## perimeter_worst         1    0.0612  1.2630 -2239.7
## area_worst              1    0.1152  1.3170 -2223.0
## smoothness_worst        1    0.0168  1.2187 -2253.9
## compactness_worst       1    0.0338  1.2357 -2248.4
## concavity_worst         1    0.0025  1.2043 -2258.6
## fractal_dimension_worst 1    0.0088  1.2107 -2256.5

reg6 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst, data=train)
drop1(reg6)

## Single term deletions
##
## Model:
```

```
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##     symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##     perimeter_se + area_se + smoothness_se + compactness_se +
##     concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##     radius_worst + texture_worst + perimeter_worst + area_worst +
##     smoothness_worst + compactness_worst + concavity_worst +
##     concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##     texture_mean - concave.points_worst - area_se - smoothness_se -
##     symmetry_worst - concavity_worst
##                         Df Sum of Sq     RSS     AIC
## <none>                               1.2043 -2258.6
## diagnosis                1    0.0032  1.2075 -2259.6
## perimeter_mean           1    9.2217 10.4260 -1401.6
## area_mean                1    0.0696  1.2740 -2238.2
## smoothness_mean          1    0.0237  1.2280 -2252.8
## compactness_mean         1    0.4874  1.6917 -2125.4
## concavity_mean           1    0.1250  1.3294 -2221.3
## concave.points_mean      1    0.0020  1.2064 -2259.9
## symmetry_mean            1    0.0037  1.2080 -2259.4
## fractal_dimension_mean   1    0.0051  1.2095 -2258.9
## radius_se                1    0.0155  1.2198 -2255.5
## texture_se               1    0.0195  1.2239 -2254.2
## perimeter_se             1    0.0362  1.2405 -2248.8
## compactness_se           1    0.0040  1.2084 -2259.3
## concavity_se             1    0.0260  1.2304 -2252.1
## concave.points_se        1    0.0328  1.2372 -2249.9
## symmetry_se              1    0.0186  1.2230 -2254.5
## fractal_dimension_se     1    0.0030  1.2074 -2259.6
## radius_worst             1    0.2549  1.4592 -2184.2
## texture_worst            1    0.0286  1.2330 -2251.2
## perimeter_worst          1    0.0614  1.2657 -2240.8
## area_worst               1    0.1151  1.3194 -2224.3
## smoothness_worst         1    0.0167  1.2211 -2255.1
## compactness_worst        1    0.0494  1.2538 -2244.6
## fractal_dimension_worst  1    0.0071  1.2114 -2258.3

reg7 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst-concave.points_mean, data=train)
drop1(reg7)

## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##     symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
```

```
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
##      smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##      texture_mean - concave.points_worst - area_se - smoothness_se -
##      symmetry_worst - concavity_worst - concave.points_mean
##                           Df Sum of Sq      RSS      AIC
## <none>                                   1.2064 -2259.9
## diagnosis                 1     0.0030  1.2094 -2260.9
## perimeter_mean            1     9.5720 10.7783 -1390.3
## area_mean                 1     0.0805  1.2869 -2236.2
## smoothness_mean           1     0.0286  1.2350 -2252.6
## compactness_mean          1     0.4872  1.6936 -2126.9
## concavity_mean            1     0.2370  1.4434 -2190.5
## symmetry_mean             1     0.0040  1.2104 -2260.6
## fractal_dimension_mean    1     0.0053  1.2116 -2260.2
## radius_se                 1     0.0153  1.2217 -2256.9
## texture_se                1     0.0201  1.2264 -2255.4
## perimeter_se              1     0.0371  1.2434 -2249.9
## compactness_se            1     0.0037  1.2101 -2260.7
## concavity_se              1     0.0281  1.2345 -2252.8
## concave.points_se         1     0.0519  1.2582 -2245.2
## symmetry_se               1     0.0184  1.2248 -2255.9
## fractal_dimension_se      1     0.0030  1.2094 -2260.9
## radius_worst              1     0.2697  1.4761 -2181.6
## texture_worst             1     0.0298  1.2362 -2252.2
## perimeter_worst           1     0.0600  1.2664 -2242.6
## area_worst                1     0.1301  1.3365 -2221.2
## smoothness_worst          1     0.0170  1.2233 -2256.4
## compactness_worst         1     0.0474  1.2538 -2246.6
## fractal_dimension_worst   1     0.0071  1.2135 -2259.6

reg8 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst-concave.points_mean-diagnosis,
data=train)
drop1(reg8)

## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
```

```
##     smoothness_worst + compactness_worst + concavity_worst +
##     concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##     texture_mean - concave.points_worst - area_se - smoothness_se -
##     symmetry_worst - concavity_worst - concave.points_mean -
##     diagnosis
##                        Df Sum of Sq     RSS     AIC
## <none>                              1.2094 -2260.9
## perimeter_mean          1    9.7089 10.9182 -1387.2
## area_mean               1    0.0785  1.2878 -2237.9
## smoothness_mean         1    0.0282  1.2376 -2253.8
## compactness_mean        1    0.4877  1.6970 -2128.1
## concavity_mean          1    0.2773  1.4867 -2180.8
## symmetry_mean           1    0.0037  1.2131 -2261.7
## fractal_dimension_mean  1    0.0052  1.2146 -2261.2
## radius_se               1    0.0143  1.2236 -2258.3
## texture_se              1    0.0215  1.2308 -2255.9
## perimeter_se            1    0.0359  1.2452 -2251.3
## compactness_se          1    0.0039  1.2132 -2261.7
## concavity_se            1    0.0352  1.2445 -2251.5
## concave.points_se       1    0.0489  1.2583 -2247.2
## symmetry_se             1    0.0206  1.2299 -2256.2
## fractal_dimension_se    1    0.0032  1.2126 -2261.9
## radius_worst            1    0.2678  1.4771 -2183.3
## texture_worst           1    0.0351  1.2444 -2251.6
## perimeter_worst         1    0.0607  1.2700 -2243.5
## area_worst              1    0.1277  1.3371 -2223.0
## smoothness_worst        1    0.0178  1.2272 -2257.1
## compactness_worst       1    0.0466  1.2559 -2247.9
## fractal_dimension_worst 1    0.0079  1.2173 -2260.4

reg9 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst-concave.points_mean-diagnosis-
fractal_dimension_se, data=train)
drop1(reg9)

## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##     symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##     perimeter_se + area_se + smoothness_se + compactness_se +
##     concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##     radius_worst + texture_worst + perimeter_worst + area_worst +
##     smoothness_worst + compactness_worst + concavity_worst +
##     concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##     texture_mean - concave.points_worst - area_se - smoothness_se -
##     symmetry_worst - concavity_worst - concave.points_mean -
```

```
##      diagnosis - fractal_dimension_se
##                          Df Sum of Sq     RSS     AIC
## <none>                                 1.2126 -2261.9
## perimeter_mean            1    9.7123 10.9249 -1389.0
## area_mean                 1    0.0783  1.2909 -2239.0
## smoothness_mean           1    0.0274  1.2400 -2255.0
## compactness_mean          1    0.4930  1.7056 -2128.1
## concavity_mean            1    0.2809  1.4935 -2181.0
## symmetry_mean             1    0.0042  1.2168 -2262.5
## fractal_dimension_mean    1    0.0070  1.2196 -2261.6
## radius_se                 1    0.0209  1.2335 -2257.1
## texture_se                1    0.0231  1.2357 -2256.4
## perimeter_se              1    0.0480  1.2606 -2248.4
## compactness_se            1    0.0012  1.2138 -2263.5
## concavity_se              1    0.0375  1.2501 -2251.8
## concave.points_se         1    0.0541  1.2667 -2246.5
## symmetry_se               1    0.0226  1.2352 -2256.6
## radius_worst              1    0.2653  1.4779 -2185.2
## texture_worst             1    0.0357  1.2483 -2252.3
## perimeter_worst           1    0.0574  1.2700 -2245.5
## area_worst                1    0.1283  1.3409 -2223.8
## smoothness_worst          1    0.0197  1.2323 -2257.5
## compactness_worst         1    0.0466  1.2592 -2248.9
## fractal_dimension_worst   1    0.0049  1.2175 -2262.3
```

```
reg10 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst-concave.points_mean-diagnosis-
fractal_dimension_se-compactness_se, data=train)
drop1(reg10)
```

```
## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
##      smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##      texture_mean - concave.points_worst - area_se - smoothness_se -
##      symmetry_worst - concavity_worst - concave.points_mean -
##      diagnosis - fractal_dimension_se - compactness_se
##                          Df Sum of Sq     RSS     AIC
## <none>                                 1.2138 -2263.5
## perimeter_mean            1    9.7624 10.9762 -1389.1
## area_mean                 1    0.0783  1.2921 -2240.6
```

```
## smoothness_mean           1    0.0286  1.2424 -2256.2
## compactness_mean          1    0.5372  1.7510 -2119.7
## concavity_mean            1    0.2918  1.5056 -2179.8
## symmetry_mean             1    0.0054  1.2192 -2263.7
## fractal_dimension_mean    1    0.0071  1.2209 -2263.2
## radius_se                 1    0.0214  1.2352 -2258.5
## texture_se                1    0.0220  1.2358 -2258.3
## perimeter_se              1    0.0504  1.2642 -2249.3
## concavity_se              1    0.0405  1.2543 -2252.4
## concave.points_se         1    0.0530  1.2667 -2248.5
## symmetry_se               1    0.0249  1.2387 -2257.4
## radius_worst              1    0.2670  1.4808 -2186.4
## texture_worst             1    0.0349  1.2486 -2254.2
## perimeter_worst           1    0.0563  1.2700 -2247.5
## area_worst                1    0.1315  1.3452 -2224.6
## smoothness_worst          1    0.0190  1.2327 -2259.3
## compactness_worst         1    0.0464  1.2602 -2250.6
## fractal_dimension_worst   1    0.0052  1.2190 -2263.8
```

```r
reg11 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst-concave.points_mean-diagnosis-
fractal_dimension_se-compactness_se-fractal_dimension_worst, data=train)
drop1(reg11)
```

```
## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##     symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##     perimeter_se + area_se + smoothness_se + compactness_se +
##     concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##     radius_worst + texture_worst + perimeter_worst + area_worst +
##     smoothness_worst + compactness_worst + concavity_worst +
##     concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##     texture_mean - concave.points_worst - area_se - smoothness_se -
##     symmetry_worst - concavity_worst - concave.points_mean -
##     diagnosis - fractal_dimension_se - compactness_se -
fractal_dimension_worst
##                          Df Sum of Sq      RSS      AIC
## <none>                                  1.2190 -2263.8
## perimeter_mean            1    9.7581 10.9771 -1391.1
## area_mean                 1    0.0795  1.2985 -2240.7
## smoothness_mean           1    0.0320  1.2510 -2255.5
## compactness_mean          1    0.5852  1.8042 -2109.8
## concavity_mean            1    0.3039  1.5229 -2177.2
## symmetry_mean             1    0.0048  1.2238 -2264.2
## fractal_dimension_mean    1    0.0021  1.2211 -2265.1
```

```
## radius_se                 1    0.0211  1.2401 -2259.0
## texture_se                1    0.0232  1.2422 -2258.3
## perimeter_se              1    0.0499  1.2689 -2249.8
## concavity_se              1    0.0422  1.2612 -2252.2
## concave.points_se         1    0.0532  1.2722 -2248.8
## symmetry_se               1    0.0218  1.2408 -2258.7
## radius_worst              1    0.2626  1.4816 -2188.2
## texture_worst             1    0.0352  1.2542 -2254.4
## perimeter_worst           1    0.0542  1.2732 -2248.5
## area_worst                1    0.1298  1.3488 -2225.5
## smoothness_worst          1    0.0220  1.2410 -2258.7
## compactness_worst         1    0.0526  1.2716 -2249.0
```

```
reg12 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst-concave.points_mean-diagnosis-
fractal_dimension_se-compactness_se-fractal_dimension_worst-
fractal_dimension_mean, data=train)
drop1(reg12)
```

```
## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##      smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##      symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##      perimeter_se + area_se + smoothness_se + compactness_se +
##      concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##      radius_worst + texture_worst + perimeter_worst + area_worst +
##      smoothness_worst + compactness_worst + concavity_worst +
##      concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##      texture_mean - concave.points_worst - area_se - smoothness_se -
##      symmetry_worst - concavity_worst - concave.points_mean -
##      diagnosis - fractal_dimension_se - compactness_se -
fractal_dimension_worst -
##      fractal_dimension_mean
##                   Df Sum of Sq     RSS      AIC
## <none>                           1.2211 -2265.1
## perimeter_mean     1   10.4460 11.6672 -1368.8
## area_mean          1    0.0878  1.3090 -2239.4
## smoothness_mean    1    0.0343  1.2554 -2256.1
## compactness_mean   1    0.8296  2.0507 -2060.8
## concavity_mean     1    0.3054  1.5265 -2178.3
## symmetry_mean      1    0.0047  1.2259 -2265.6
## radius_se          1    0.0203  1.2414 -2260.6
## texture_se         1    0.0249  1.2460 -2259.1
## perimeter_se       1    0.0491  1.2703 -2251.4
## concavity_se       1    0.0466  1.2677 -2252.2
## concave.points_se  1    0.0518  1.2729 -2250.6
```

```
## symmetry_se          1     0.0221   1.2432 -2260.0
## radius_worst         1     0.2719   1.4930 -2187.1
## texture_worst        1     0.0384   1.2596 -2254.8
## perimeter_worst      1     0.0568   1.2780 -2249.0
## area_worst           1     0.1315   1.3526 -2226.4
## smoothness_worst     1     0.0214   1.2425 -2260.2
## compactness_worst    1     0.0510   1.2721 -2250.8
```

```
reg13 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst-concave.points_mean-diagnosis-
fractal_dimension_se-compactness_se-fractal_dimension_worst-
fractal_dimension_mean-symmetry_mean, data=train)
drop1(reg13)
```

```
## Single term deletions
##
## Model:
## radius_mean ~ (diagnosis + texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean +
concave.points_mean +
##     symmetry_mean + fractal_dimension_mean + radius_se + texture_se +
##     perimeter_se + area_se + smoothness_se + compactness_se +
##     concavity_se + concave.points_se + symmetry_se + fractal_dimension_se
+
##     radius_worst + texture_worst + perimeter_worst + area_worst +
##     smoothness_worst + compactness_worst + concavity_worst +
##     concave.points_worst + symmetry_worst + fractal_dimension_worst) -
##     texture_mean - concave.points_worst - area_se - smoothness_se -
##     symmetry_worst - concavity_worst - concave.points_mean -
##     diagnosis - fractal_dimension_se - compactness_se -
fractal_dimension_worst -
##     fractal_dimension_mean - symmetry_mean
##                      Df Sum of Sq     RSS      AIC
## <none>                            1.2259 -2265.6
## perimeter_mean        1   10.4955 11.7214 -1369.0
## area_mean             1    0.0908  1.3167 -2239.1
## smoothness_mean       1    0.0405  1.2663 -2254.6
## compactness_mean      1    0.8249  2.0508 -2062.8
## concavity_mean        1    0.3006  1.5265 -2180.3
## radius_se             1    0.0241  1.2499 -2259.8
## texture_se            1    0.0239  1.2497 -2259.9
## perimeter_se          1    0.0544  1.2803 -2250.3
## concavity_se          1    0.0442  1.2700 -2253.5
## concave.points_se     1    0.0514  1.2773 -2251.2
## symmetry_se           1    0.0175  1.2434 -2261.9
## radius_worst          1    0.2729  1.4987 -2187.6
## texture_worst         1    0.0376  1.2634 -2255.5
## perimeter_worst       1    0.0549  1.2808 -2250.1
## area_worst            1    0.1370  1.3628 -2225.4
```

```
## smoothness_worst    1     0.0232  1.2490 -2260.1
## compactness_worst   1     0.0529  1.2788 -2250.7
```

with reg13 me, rmse and mape were slightly reduced compared to the original dataset

```
################################################################################
## 5. testing the quality of both regression models (The orignal and the
latest one)
################################################################################

predict = predict(reg13, eval)
me = mean(eval$radius_mean-predict)
me
```

```
## [1] 0.0102765
```

```
rmse = sqrt(mean((eval$radius_mean-predict)**2))
rmse
```

```
## [1] 0.06643954
```

```
mape = mean(abs(eval$radius_mean-predict)/eval$radius_mean)*100
mape
```

```
## [1] 0.3295522
```

```
predictCV = length(df)
```

```
################################################################################
## 6. Perform cross validation on both models
################################################################################

##cross-validation (full) - leave-one-out-method

for (k in 1:length(df$radius_mean)) {
  eval = df[k,]
  train = df[-k,]
  # here we use the leave-one-out-method on the whole dataFrame
  m1 = lm(radius_mean~.,data=train)
  predictCV[k] = predict(m1,eval)
}

me = mean(df$radius_mean-predictCV)
me
```

```
## [1] -0.00007908341
```

```
rmse = sqrt(mean((df$radius_mean-predictCV)**2))
rmse
```

```
## [1] 0.06459013
```

```r
mape = mean(abs(df$radius_mean-predictCV)/df$radius_mean)*100
mape
```

```
## [1] 0.3030293
```

```r
##cross-validation(reduced)
for (k in 1:length(df$radius_mean)) {
  eval = df[k,]
  train = df[-k,]
# here we exclude the columns we identified as not necessary
  m1 = lm(radius_mean~.-texture_mean-concave.points_worst-area_se-
smoothness_se-symmetry_worst-concavity_worst-concave.points_mean-diagnosis-
fractal_dimension_se-compactness_se-fractal_dimension_worst-
fractal_dimension_mean-symmetry_mean, data=train)
  predictCV[k] = predict(m1,eval)
}

me = mean(df$radius_mean-predictCV)
me
```

```
## [1] 0.0001016514
```

```r
rmse = sqrt(mean((df$radius_mean-predictCV)**2))
rmse
```

```
## [1] 0.06221155
```

```r
mape = mean(abs(df$radius_mean-predictCV)/df$radius_mean)*100
mape
```

```
## [1] 0.2961335
```