Lab-07

Random Forests

First will will need to load the dplyr library, so we can read in csv files.

```
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 3.3.3
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
titanic3 = read.csv("..\\..\\Week08\\titanic3.cSV", header = TRUE)
```

Once the data has been load, We can remove features from the dataset that will not be require for our tree models.

```
titanic3=select(titanic3, -name, -ticket, -boat, -body, -home.dest, -cabin) %>% mutate(embarked = factor
```

```
## Warning: package 'bindrcpp' was built under R version 3.3.3
```

```
summary(titanic3)
```

```
##  pclass     survived         sex           age              sibsp
##   :  3   Min.   :0.000         :  1   Min.   : 0.1667   Min.   :0.0000
##  C:270   1st Qu.:0.000   female:466   1st Qu.:21.0000   1st Qu.:0.0000
##  Q:123   Median :0.000   male  :843   Median :28.0000   Median :0.0000
##  S:914   Mean   :0.382                Mean   :29.8811   Mean   :0.4989
##          3rd Qu.:1.000                3rd Qu.:39.0000   3rd Qu.:1.0000
##          Max.   :1.000                Max.   :80.0000   Max.   :8.0000
##          NA's   :1                    NA's   :264       NA's   :1
##      parch            fare          embarked
##  Min.   :0.000   Min.   :  0.000    :  3
##  1st Qu.:0.000   1st Qu.:  7.896   C:270
##  Median :0.000   Median : 14.454   Q:123
##  Mean   :0.385   Mean   : 33.295   S:914
##  3rd Qu.:0.000   3rd Qu.: 31.275
##  Max.   :9.000   Max.   :512.329
##  NA's   :1       NA's   :2
```

Part 1: Feature Transformation

We will first need to clean and transform the data so it is optimised for our model. We will initially add a new variable survived01, which is a categorical equivalent of survived.

```r
titanic3$survived01 = as.factor(titanic3$survived)

append(titanic3$survived01, titanic3)
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##  [116]  0  1  1  0  1  1  1  1  1  1  0  0  1  0  1  1  1  0  1  1  0  1  1
##  [139]  0  1  1  1  0  1  1  1  1  0  0  1  0  1  1  1  0  1  0  0  0  1  1
##  [162]  1  0  1  1  1  0  1  1  0  1  0  0  0  0  0  1  1  1  0  1  1  1  1
##  [185]  0  0  1  1  1  0  1  0  1  1  0  1  1  0  1  1  0  0  1  0  1  0  0
##  [208]  1  1  1  0  0  0  1  1  0  1  0  1  1  1  0  0  0  0  0  0  1  0  1
##  [231]  1  1  0  1  0  1  0  0  1  0  1  0  1  0  0  1  0  1  0  1  1  1  0
##  [254]  1  1  1  1  1  1  1  1  1  0  1  1  1  0  0  0  0  1  1  1  1  1  1
##  [277]  0  1  1  0  1  1  1  0  1  0  0  0  1  1  0  1  1  1  0  1  1  1  1
##  [300]  0  0  0  1  0  1  0  0  0  1  1  0  1  0  0  1  1  0  1  0  1  1  0
##  [323]  1  0  1  0  0  0  0  1  0  0  0  1  0  0  1  1  0  1  1  1  1  1  1
##  [346]  0  0  0  0  1  1  0  1  1  0  1  0  0  1  1  1  1  1  0  0  0  0  0
##  [369]  0  0  1  1  0  1  0  0  1  1  0  1  1  0  0  0  0  1  0  1  1  0  0
##  [392]  0  1  0  0  1  1  0  1  0  1  1  1  0  0  0  0  1  0  0  0  0  0  0
##  [415]  0  1  0  0  0  0  0  0  0  0  0  0  0  1  1  0  1  0  1  0  1  0  1
```

```
##  [438]  1  1  0  1  1  0  0  0  0  1  0  0  1  0  0  1  0  1  0  0  0  1  0
##  [461]  1  0  0  0  0  1  0  1  0  1  0  1  0  0  0  0  0  0  1  1  0  1  1
##  [484]  1  1  0  0  0  0  1  0  0  1  0  1  0  0  0  0  0  0  1  1  1  0  0
##  [507]  0  0  0  0  0  0  0  1  1  1  0  0  0  0  1  1  0  1  1  0  1  0  0
##  [530]  1  0  0  0  1  1  0  1  0  1  0  1  1  1  0  0  1  1  0  1  1  1  1
##  [553]  0  1  0  0  0  1  1  1  1  0  1  0  1  0  0  0  0  0  1  0  1  1  0
##  [576]  0  0  1  0  0  1  0  1  1  1  0  1  1  1  1  1  1  0  1  0  0  1  1
##  [599]  1  0  0  0  0  1  1  1  1  1  0  0  0  1  1  1  0  0  0  0  0  0  0
##  [622]  1  0  0  0  1  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  1  0  1
##  [645]  0  1  1  1  0  0  0  0  0  1  0  0  1  1  1  1  1  1  0  0  1  0  0
##  [668]  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0
##  [691]  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0
##  [714]  0  1  0  0  0  0  1  0  0  0  0  0  1  0  0  0  0  0  0  0  1  1  1
##  [737]  0  0  1  0  0  0  1  0  0  1  1  0  0  0  0  0  0  0  0  0  0  1  1
##  [760]  1  1  0  1  1  0  1  0  0  0  0  0  1  0  0  0  0  0  1  1  0  1  0
##  [783]  0  1  0  1  0  0  0  0  0  0  0  0  1  0  0  0  1  0  0  0  0  0  0
##  [806]  1  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1  0  0  1  0  0  0  0
##  [829]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0
##  [852]  1  0  0  0  0  1  1  1  0  1  0  1  0  0  0  1  1  0  0  1  0  1  0
##  [875]  1  0  0  0  0  0  1  1  0  0  0  0  1  1  0  1  0  0  0  0  1  1  0
##  [898]  0  0  1  0  0  0  0  0  1  0  0  0  1  0  0  0  1  0  0  1  1  0  0
##  [921]  0  0  1  1  0  0  1  0  0  0  0  0  0  0  0  1  1  1  0  0  0  0  1  0
##  [944]  0  0  1  0  1  0  1  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [967]  0  0  0  0  1  0  0  0  0  0  0  0  0  1  0  1  1  0  0  1  1  0  0  0
##  [990]  0  0  1  0  1  0  0  0  1  0  1  1  1  1  1  1  0  1  1  0  0  0  0
## [1013]  0  0  0  0  0  1  0  0  0  0  0  0  1  0  1  1  0  1  0  0  0  0  1  1
## [1036]  1  1  1  0  1  1  0  1  1  1  0  0  1  1  1  1  0  0  0  0  0  1  1
## [1059]  0  0  1  1  0  0  1  0  0  1  0  0  0  1  0  0  0  0  0  1  1  1  1
## [1082]  1  1  0  0  0  0  0  1  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
## [1105]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  0  0  0
## [1128]  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1
## [1151]  0  0  0  0  0  0  0  0  0  0  1  0  0  1  0  0  0  0  0  0  0  0  0  0  0
## [1174]  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  1  1  1  1  0  0  0  0  0
## [1197]  1  0  1  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  1  0  0
## [1220]  0  0  0  0  1  0  0  0  0  1  0  0  0  1  1  0  0  1  0  1  0  1  0
## [1243]  0  0  1  0  0  1  0  0  0  0  0  0  0  1  0  1  1  1  0  1  1  0  0  0
## [1266]  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  1  0
## [1289]  0  0  1  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0 NA
##
## $sex
##    [1] female male   female male   female male   female male   female
##   [10] male   male   female female female male   male   male   female
##   [19] female male   male   female male   female female male   male
##   [28] female female male   male   male   female female male   female
##   [37] female male   male   male   male   female female female female
##   [46] male   male   male   female male   female male   male   male
##   [55] male   female male   female male   female male   female male
##   [64] female male   female female female male   female male   male
##   [73] female female male   male   female male   female female male
##   [82] male   female female male   female male   male   female male
##   [91] female male   female male   male   female male   female female
##  [100] female male   male   female female female female male   female
##  [109] female male   male   female female female male   male   female
##  [118] female male   male   male   female female male   female male
```

```
##  [127] male   female male   female female female male   male   female
##  [136] male   male   female male   female male   female male   male
##  [145] female male   female male   male   female male   male   male
##  [154] female male   female male   male   male   female female female
##  [163] male   female male   male   male   female female female male
##  [172] male   male   male   male   male   female male   female male
##  [181] female female female male   male   male   female female female
##  [190] male   female male   female female male   female male   male
##  [199] female female male   male   male   male   female male   male
##  [208] female female male   male   male   male   female female male
##  [217] female male   female male   female male   male   male   male
##  [226] male   male   female male   female female male   male   female
##  [235] male   male   male   male   female male   male   male   female
##  [244] male   male   female male   female male   male   female female
##  [253] male   female male   female male   female female male   female
##  [262] male   male   female male   male   male   male   male   male
##  [271] female male   female male   male   female male   female male
##  [280] male   male   female female male   female male   female male
##  [289] female female male   female male   female male   male   female
##  [298] female male   male   male   male   female male   female male
##  [307] male   male   female female male   female male   male   female
##  [316] female male   male   male   female male   male   female male
##  [325] female male   male   male   male   female male   male   male
##  [334] female male   male   male   female male   male   female female
##  [343] female male   female male   male   male   male   female female
##  [352] male   female female male   female male   male   female male
##  [361] male   female female male   male   female male   male   male
##  [370] female female female male   female male   male   male   female
##  [379] male   female female female female male   male   male   male
##  [388] female female male   male   male   female male   male   female
##  [397] female male   male   male   female female female male   male
##  [406] male   male   female male   male   male   female male   male
##  [415] male   female male   male   male   male   male   male   male
##  [424] male   male   male   male   male   female male   female male
##  [433] male   male   female male   female female female male   female
##  [442] female male   male   male   female female male   male   female
##  [451] male   male   female male   male   male   female male   female
##  [460] male   female male   male   male   male   female male   female
##  [469] female female male   female male   male   male   female male
##  [478] male   female female male   female female female female male
##  [487] male   male   male   female female male   male   male   female
##  [496] male   male   male   male   male   male   female female male
##  [505] male   male   male   male   male   male   male   male   male
##  [514] female male   male   male   male   male   male   male   female
##  [523] male   male   male   male   male   male   male   female male
##  [532] male   male   female female male   female male   male   male
##  [541] female female female male   male   female female male   male
##  [550] male   female female male   female male   male   male   female
##  [559] female female female male   female male   female male   male
##  [568] male   male   male   female male   female female male   female
##  [577] male   female male   male   female male   female female female
##  [586] male   female male   female female female female male   female
##  [595] male   male   male   male   female female male   male   male
##  [604] female female male   male   female male   male   female male
```

```
##  [613] female male   male   male   male   male   male   male   male
##  [622] female male   female female female female female female male
##  [631] male   male   female male   male   male   female male   male
##  [640] male   male   male   male   female male   male   female female
##  [649] male   male   female male   male   female male   male   female
##  [658] female female female female female male   male   male   female
##  [667] female female male   male   male   male   male   male   male
##  [676] male   male   male   male   female male   female female male
##  [685] female male   female female male   male   male   male   female
##  [694] male   male   female female female male   male   male   male
##  [703] female male   male   male   female male   male   female female
##  [712] male   male   male   male   male   male   male   male   male
##  [721] male   male   male   male   male   female female male   male
##  [730] male   male   male   male   male   male   female male   male
##  [739] female male   male   male   male   female male   female male
##  [748] male   male   female male   male   male   male   male   male
##  [757] male   female male   female male   male   male   female male
##  [766] female male   male   male   male   male   female male   male
##  [775] male   male   male   male   female female female male   male
##  [784] male   male   female male   male   male   male   male   male
##  [793] male   male   female male   male   male   male   male   female
##  [802] male   male   male   male   male   female female male   male
##  [811] male   female male   male   male   male   male   male   female
##  [820] female male   male   male   female male   male   male   male
##  [829] female female male   male   female male   male   male   male
##  [838] male   male   male   female female male   male   male   female
##  [847] male   male   male   male   male   female female male   male
##  [856] male   female male   male   female female female female male
##  [865] female female female female male   male   female male   female
##  [874] male   male   male   male   female female male   male   male
##  [883] male   male   male   male   female male   male   male   male
##  [892] male   male   male   male   female male   male   male   female
##  [901] male   female male   female male   male   male   female female
##  [910] male   male   male   male   male   male   male   female male
##  [919] male   male   male   male   female female male   male   male
##  [928] male   female male   male   male   female male   female male
##  [937] female female male   female male   male   male   female male
##  [946] male   male   female male   male   male   male   male   male
##  [955] male   female female female female male   male   female male
##  [964] male   male   male   female female male   female male   male
##  [973] male   male   male   female male   male   male   male   female
##  [982] male   male   male   female male   male   female male   male
##  [991] male   male   female female male   male   male   female male
## [1000] female male   female female male   female male   female female
## [1009] female male   male   female female female female male   male
## [1018] male   male   male   male   male   male   female male   male
## [1027] female male   female male   male   male   male   male   male
## [1036] male   female female male   female female male   female female
## [1045] female male   male   female female male   female male   male
## [1054] male   female male   male   female female male   female female
## [1063] male   male   male   male   male   female male   male   male
## [1072] female male   male   male   male   female female female female
## [1081] male   female male   male   male   male   female male   male
## [1090] male   female female male   male   female female male   male
```

```
## [1099] female female female male   male   male   male   male   female
## [1108] male   male   male   male   male   female female male   male
## [1117] male   male   male   male   male   male   female female female
## [1126] male   female male   male   male   female male   male   male
## [1135] male   male   female male   male   male   male   male   male
## [1144] male   male   male   female female male   female male   female
## [1153] male   female male   male   female male   female female male
## [1162] male   male   male   male   male   male   male   male   male
## [1171] male   male   female female female female male   male   male
## [1180] male   female male   female male   male   male   male   female
## [1189] female female male   male   male   male   male   male   male
## [1198] male   female male   male   male   male   male   male   female
## [1207] male   male   female female male   female male   male   male
## [1216] male   female male   male   male   male   male   male   female
## [1225] male   male   male   female male   male   female female male
## [1234] male   male   male   male   male   male   male   male   male
## [1243] male   male   female male   male   female male   male   male
## [1252] male   male   male   male   male   male   female female male
## [1261] female female male   male   male   female male   female male
## [1270] male   male   male   male   female male   male   female male
## [1279] male   female male   male   male   male   male   male   female
## [1288] male   male   male   female male   male   male   male   male
## [1297] male   male   male   male   female male   male   male   female
## [1306] female male   male   male
## Levels:  female male
##
## $age
##    [1] 29.0000  0.9167  2.0000 30.0000 25.0000 48.0000 63.0000 39.0000
##    [9] 53.0000 71.0000 47.0000 18.0000 24.0000 26.0000 80.0000      NA
##   [17] 24.0000 50.0000 32.0000 36.0000 37.0000 47.0000 26.0000 42.0000
##   [25] 29.0000 25.0000 25.0000 19.0000 35.0000 28.0000 45.0000 40.0000
##   [33] 30.0000 58.0000 42.0000 45.0000 22.0000      NA 41.0000 48.0000
##   [41]      NA 44.0000 59.0000 60.0000 41.0000 45.0000      NA 42.0000
##   [49] 53.0000 36.0000 58.0000 33.0000 28.0000 17.0000 11.0000 14.0000
##   [57] 36.0000 36.0000 49.0000      NA 36.0000 76.0000 46.0000 47.0000
##   [65] 27.0000 33.0000 36.0000 30.0000 45.0000      NA      NA 27.0000
##   [73] 26.0000 22.0000      NA 47.0000 39.0000 37.0000 64.0000 55.0000
##   [81]      NA 70.0000 36.0000 64.0000 39.0000 38.0000 51.0000 27.0000
##   [89] 33.0000 31.0000 27.0000 31.0000 17.0000 53.0000  4.0000 54.0000
##   [97] 50.0000 27.0000 48.0000 48.0000 49.0000 39.0000 23.0000 38.0000
##  [105] 54.0000 36.0000      NA      NA      NA 36.0000 30.0000 24.0000
##  [113] 28.0000 23.0000 19.0000 64.0000 60.0000 30.0000      NA 50.0000
##  [121] 43.0000      NA 22.0000 60.0000 48.0000      NA 37.0000 35.0000
##  [129] 47.0000 35.0000 22.0000 45.0000 24.0000 49.0000      NA 71.0000
##  [137] 53.0000 19.0000 38.0000 58.0000 23.0000 45.0000 46.0000 25.0000
##  [145] 25.0000 48.0000 49.0000      NA 45.0000 35.0000 40.0000 27.0000
##  [153]      NA 24.0000 55.0000 52.0000 42.0000      NA 55.0000 16.0000
##  [161] 44.0000 51.0000 42.0000 35.0000 35.0000 38.0000      NA 35.0000
##  [169] 38.0000 50.0000 49.0000 46.0000 50.0000 32.5000 58.0000 41.0000
##  [177]      NA 42.0000 45.0000      NA 39.0000 49.0000 30.0000 35.0000
##  [185]      NA 42.0000 55.0000 16.0000 51.0000 29.0000 21.0000 30.0000
##  [193] 58.0000 15.0000 30.0000 16.0000      NA 19.0000 18.0000 24.0000
##  [201] 46.0000 54.0000 36.0000 28.0000      NA 65.0000 44.0000 33.0000
##  [209] 37.0000 30.0000 55.0000 47.0000 37.0000 31.0000 23.0000 58.0000
```

```
##  [217] 19.0000 64.0000 39.0000      NA 22.0000 65.0000 28.5000      NA
##  [225] 45.5000 23.0000 29.0000 22.0000 18.0000 17.0000 30.0000 52.0000
##  [233] 47.0000 56.0000 38.0000      NA 22.0000      NA 43.0000 31.0000
##  [241] 45.0000      NA 33.0000 46.0000 36.0000 33.0000 55.0000 54.0000
##  [249] 33.0000 13.0000 18.0000 21.0000 61.0000 48.0000      NA 24.0000
##  [257]      NA 35.0000 30.0000 34.0000 40.0000 35.0000 50.0000 39.0000
##  [265] 56.0000 28.0000 56.0000 56.0000 24.0000      NA 18.0000 24.0000
##  [273] 23.0000  6.0000 45.0000 40.0000 57.0000      NA 32.0000 62.0000
##  [281] 54.0000 43.0000 52.0000      NA 62.0000 67.0000 63.0000 61.0000
##  [289] 48.0000 18.0000 52.0000 39.0000 48.0000      NA 49.0000 17.0000
##  [297] 39.0000      NA 31.0000 40.0000 61.0000 47.0000 35.0000 64.0000
##  [305] 60.0000 60.0000 54.0000 21.0000 55.0000 31.0000 57.0000 45.0000
##  [313] 50.0000 27.0000 50.0000 21.0000 51.0000 21.0000      NA 31.0000
##  [321]      NA 62.0000 36.0000 30.0000 28.0000 30.0000 18.0000 25.0000
##  [329] 34.0000 36.0000 57.0000 18.0000 23.0000 36.0000 28.0000 51.0000
##  [337] 32.0000 19.0000 28.0000  1.0000  4.0000 12.0000 36.0000 34.0000
##  [345] 19.0000 23.0000 26.0000 42.0000 27.0000 24.0000 15.0000 60.0000
##  [353] 40.0000 20.0000 25.0000 36.0000 25.0000 42.0000 42.0000  0.8333
##  [361] 26.0000 22.0000 35.0000      NA 19.0000 44.0000 54.0000 52.0000
##  [369] 37.0000 29.0000 25.0000 45.0000 29.0000 28.0000 29.0000 28.0000
##  [377] 24.0000  8.0000 31.0000 31.0000 22.0000 30.0000      NA 21.0000
##  [385]      NA  8.0000 18.0000 48.0000 28.0000 32.0000 17.0000 29.0000
##  [393] 24.0000 25.0000 18.0000 18.0000 34.0000 54.0000  8.0000 42.0000
##  [401] 34.0000 27.0000 30.0000 23.0000 21.0000 18.0000 40.0000 29.0000
##  [409] 18.0000 36.0000      NA 38.0000 35.0000 38.0000 34.0000 34.0000
##  [417] 16.0000 26.0000 47.0000 21.0000 21.0000 24.0000 24.0000 34.0000
##  [425] 30.0000 52.0000 30.0000  0.6667 24.0000 44.0000  6.0000 28.0000
##  [433] 62.0000 30.0000  7.0000 43.0000 45.0000 24.0000 24.0000 49.0000
##  [441] 48.0000 55.0000 24.0000 32.0000 21.0000 18.0000 20.0000 23.0000
##  [449] 36.0000 54.0000 50.0000 44.0000 29.0000 21.0000 42.0000 63.0000
##  [457] 60.0000 33.0000 17.0000 42.0000 24.0000 47.0000 24.0000 22.0000
##  [465] 32.0000 23.0000 34.0000 24.0000 22.0000      NA 35.0000 45.0000
##  [473] 57.0000      NA 31.0000 26.0000 30.0000      NA  1.0000  3.0000
##  [481] 25.0000 22.0000 17.0000      NA 34.0000 36.0000 24.0000 61.0000
##  [489] 50.0000 42.0000 57.0000      NA  1.0000 31.0000 24.0000      NA
##  [497] 30.0000 40.0000 32.0000 30.0000 46.0000 13.0000 41.0000 19.0000
##  [505] 39.0000 48.0000 70.0000 27.0000 54.0000 39.0000 16.0000 62.0000
##  [513] 32.5000 14.0000  2.0000  3.0000 36.5000 26.0000 19.0000 28.0000
##  [521] 20.0000 29.0000 39.0000 22.0000      NA 23.0000 29.0000 28.0000
##  [529]      NA 50.0000 19.0000      NA 41.0000 21.0000 19.0000 43.0000
##  [537] 32.0000 34.0000 30.0000 27.0000  2.0000  8.0000 33.0000 36.0000
##  [545] 34.0000 30.0000 28.0000 23.0000  0.8333  3.0000 24.0000 50.0000
##  [553] 19.0000 21.0000 26.0000 25.0000 27.0000 25.0000 18.0000 20.0000
##  [561] 30.0000 59.0000 30.0000 35.0000 40.0000 25.0000 41.0000 25.0000
##  [569] 18.5000 14.0000 50.0000 23.0000 28.0000 27.0000 29.0000 27.0000
##  [577] 40.0000 31.0000 30.0000 23.0000 31.0000      NA 12.0000 40.0000
##  [585] 32.5000 27.0000 29.0000  2.0000  4.0000 29.0000  0.9167  5.0000
##  [593] 36.0000 33.0000 66.0000      NA 31.0000      NA 26.0000 24.0000
##  [601] 42.0000 13.0000 16.0000 35.0000 16.0000 25.0000 20.0000 18.0000
##  [609] 30.0000 26.0000 40.0000  0.8333 18.0000 26.0000 26.0000 20.0000
##  [617] 24.0000 25.0000 35.0000 18.0000 32.0000 19.0000  4.0000  6.0000
##  [625]  2.0000 17.0000 38.0000  9.0000 11.0000 39.0000 27.0000 26.0000
##  [633] 39.0000 20.0000 26.0000 25.0000 18.0000 24.0000 35.0000  5.0000
##  [641]  9.0000  3.0000 13.0000  5.0000 40.0000 23.0000 38.0000 45.0000
```

```
##  [649] 21.0000 23.0000 17.0000 30.0000 23.0000 13.0000 20.0000 32.0000
##  [657] 33.0000  0.7500  0.7500  5.0000 24.0000 18.0000 40.0000 26.0000
##  [665] 20.0000 18.0000 45.0000 27.0000 22.0000 19.0000 26.0000 22.0000
##  [673]      NA 20.0000 32.0000 21.0000 18.0000 26.0000  6.0000  9.0000
##  [681]      NA      NA      NA 40.0000 32.0000 21.0000 22.0000 20.0000
##  [689] 29.0000 22.0000 22.0000 35.0000 18.5000 21.0000 19.0000 18.0000
##  [697] 21.0000 30.0000 18.0000 38.0000 17.0000 17.0000 21.0000 21.0000
##  [705] 21.0000      NA      NA 28.0000 24.0000 16.0000 37.0000 28.0000
##  [713] 24.0000 21.0000 32.0000 29.0000 26.0000 18.0000 20.0000 18.0000
##  [721] 24.0000 36.0000 24.0000 31.0000 31.0000 22.0000 30.0000 70.5000
##  [729] 43.0000 35.0000 27.0000 19.0000 30.0000  9.0000  3.0000 36.0000
##  [737] 59.0000 19.0000 17.0000 44.0000 17.0000 22.5000 45.0000 22.0000
##  [745] 19.0000 30.0000 29.0000  0.3333 34.0000 28.0000 27.0000 25.0000
##  [753] 24.0000 22.0000 21.0000 17.0000      NA      NA 36.5000 36.0000
##  [761] 30.0000 16.0000  1.0000  0.1667 26.0000 33.0000 25.0000      NA
##  [769]      NA 22.0000 36.0000 19.0000 17.0000 42.0000 43.0000      NA
##  [777] 32.0000 19.0000 30.0000 24.0000 23.0000 33.0000 65.0000 24.0000
##  [785] 23.0000 22.0000 18.0000 16.0000 45.0000      NA 39.0000 17.0000
##  [793] 15.0000 47.0000  5.0000      NA 40.5000 40.5000      NA 18.0000
##  [801]      NA      NA      NA 26.0000      NA      NA 21.0000  9.0000
##  [809]      NA 18.0000 16.0000 48.0000      NA      NA 25.0000      NA
##  [817]      NA 22.0000 16.0000      NA  9.0000 33.0000 41.0000 31.0000
##  [825] 38.0000  9.0000  1.0000 11.0000 10.0000 16.0000 14.0000 40.0000
##  [833] 43.0000 51.0000 32.0000      NA 20.0000 37.0000 28.0000 19.0000
##  [841] 24.0000 17.0000      NA      NA 28.0000 24.0000 20.0000 23.5000
##  [849] 41.0000 26.0000 21.0000 45.0000      NA 25.0000      NA 11.0000
##  [857]      NA 27.0000      NA 18.0000 26.0000 23.0000 22.0000 28.0000
##  [865] 28.0000      NA  2.0000 22.0000 43.0000 28.0000 27.0000      NA
##  [873]      NA 42.0000      NA 30.0000      NA 27.0000 25.0000      NA
##  [881] 29.0000 21.0000      NA 20.0000 48.0000 17.0000      NA      NA
##  [889] 34.0000 26.0000 22.0000 33.0000 31.0000 29.0000  4.0000  1.0000
##  [897] 49.0000 33.0000 19.0000 27.0000      NA      NA      NA      NA
##  [905] 23.0000 32.0000 27.0000 20.0000 21.0000 32.0000 17.0000 21.0000
##  [913] 30.0000 21.0000 33.0000 22.0000  4.0000 39.0000      NA 18.5000
##  [921]      NA      NA      NA      NA 34.5000 44.0000      NA      NA
##  [929]      NA      NA      NA      NA 22.0000 26.0000  4.0000 29.0000
##  [937] 26.0000  1.0000 18.0000 36.0000      NA 25.0000      NA 37.0000
##  [945]      NA      NA      NA 22.0000      NA 26.0000 29.0000 29.0000
##  [953] 22.0000 22.0000      NA      NA      NA      NA      NA 32.0000
##  [961] 34.5000      NA      NA 36.0000 39.0000 24.0000 25.0000 45.0000
##  [969] 36.0000 30.0000 20.0000      NA 28.0000      NA 30.0000 26.0000
##  [977]      NA 20.5000 27.0000 51.0000 23.0000 32.0000      NA      NA
##  [985]      NA 24.0000 22.0000      NA      NA      NA 29.0000      NA
##  [993] 30.5000      NA      NA 35.0000 33.0000      NA      NA      NA
## [1001]      NA      NA      NA      NA      NA      NA      NA 15.0000
## [1009] 35.0000      NA 24.0000 19.0000      NA      NA      NA 55.5000
## [1017]      NA 21.0000      NA 24.0000 21.0000 28.0000      NA      NA
## [1025] 25.0000  6.0000 27.0000      NA      NA      NA      NA 34.0000
## [1033]      NA      NA      NA      NA      NA      NA      NA      NA
## [1041] 24.0000      NA      NA      NA      NA 18.0000 22.0000 15.0000
## [1049]  1.0000 20.0000 19.0000 33.0000      NA      NA      NA      NA
## [1057] 12.0000 14.0000 29.0000 28.0000 18.0000 26.0000 21.0000 41.0000
## [1065] 39.0000 21.0000 28.5000 22.0000 61.0000      NA      NA      NA
## [1073]      NA      NA      NA 23.0000      NA      NA      NA 22.0000
```

```
## [1081]      NA      NA  9.0000 28.0000 42.0000      NA 31.0000 28.0000
## [1089] 32.0000 20.0000 23.0000 20.0000 20.0000 16.0000 31.0000      NA
## [1097]  2.0000  6.0000  3.0000  8.0000 29.0000  1.0000  7.0000  2.0000
## [1105] 16.0000 14.0000 41.0000 21.0000 19.0000      NA 32.0000  0.7500
## [1113]  3.0000 26.0000      NA      NA      NA 21.0000 25.0000 22.0000
## [1121] 25.0000      NA      NA      NA      NA 24.0000 28.0000 19.0000
## [1129]      NA 25.0000 18.0000 32.0000      NA 17.0000 24.0000      NA
## [1137]      NA      NA      NA 38.0000 21.0000 10.0000  4.0000  7.0000
## [1145]  2.0000  8.0000 39.0000 22.0000 35.0000      NA      NA      NA
## [1153] 50.0000 47.0000      NA      NA  2.0000 18.0000 41.0000      NA
## [1161] 50.0000 16.0000      NA      NA      NA 25.0000      NA      NA
## [1169]      NA 38.5000      NA 14.5000      NA      NA      NA      NA
## [1177]      NA      NA      NA      NA      NA 24.0000 21.0000 39.0000
## [1185]      NA      NA      NA  1.0000 24.0000  4.0000 25.0000 20.0000
## [1193] 24.5000      NA      NA      NA 29.0000      NA      NA      NA
## [1201]      NA 22.0000      NA 40.0000 21.0000 18.0000  4.0000 10.0000
## [1209]  9.0000  2.0000 40.0000 45.0000      NA      NA      NA      NA
## [1217]      NA 19.0000 30.0000      NA 32.0000      NA 33.0000 23.0000
## [1225] 21.0000 60.5000 19.0000 22.0000 31.0000 27.0000  2.0000 29.0000
## [1233] 16.0000 44.0000 25.0000 74.0000 14.0000 24.0000 25.0000 34.0000
## [1241]  0.4167      NA      NA      NA 16.0000      NA      NA      NA
## [1249] 32.0000      NA      NA 30.5000 44.0000      NA 25.0000      NA
## [1257]  7.0000  9.0000 29.0000 36.0000 18.0000 63.0000      NA 11.5000
## [1265] 40.5000 10.0000 36.0000 30.0000      NA 33.0000 28.0000 28.0000
## [1273] 47.0000 18.0000 31.0000 16.0000 31.0000 22.0000 20.0000 14.0000
## [1281] 22.0000 22.0000      NA      NA      NA 32.5000 38.0000 51.0000
## [1289] 18.0000 21.0000 47.0000      NA      NA      NA 28.5000 21.0000
## [1297] 27.0000      NA 36.0000 27.0000 15.0000 45.5000      NA      NA
## [1305] 14.5000      NA 26.5000 27.0000 29.0000      NA
##
## $sibsp
##    [1]  0  1  1  1  1  0  1  0  2  0  1  1  0  0  0  0  0  0  0  0  1  1  0
##   [24]  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0
##   [47]  0  0  0  0  0  0  0  0  1  1  1  1  0  0  1  1  1  1  1  1  0  0  0
##   [70]  0  0  1  1  0  0  0  1  1  0  2  0  1  0  1  1  1  0  0  0  1  1  1
##   [93]  1  1  0  1  1  1  1  1  1  0  0  0  1  0  0  0  0  0  0  3  3  3  3
##  [116]  1  1  0  0  2  1  1  0  1  1  0  1  1  0  0  0  0  0  1  1  0  0  0
##  [139]  0  0  0  0  0  1  1  1  1  0  1  1  0  0  0  0  1  1  0  0  0  0  0
##  [162]  1  1  1  0  1  0  1  0  0  0  0  0  0  0  0  1  1  1  1  0  0  0  0  0
##  [185]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  1  1  0  2
##  [208]  1  1  1  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1
##  [231]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  2  2  2  1
##  [254]  1  0  0  0  1  0  0  0  0  1  1  0  0  0  0  1  0  1  1  1  0  1  1
##  [277]  1  1  0  0  1  1  1  0  0  1  1  0  0  0  1  1  1  1  1  0  1  0  0
##  [300]  0  0  0  0  1  1  0  0  0  0  0  1  1  1  0  1  0  0  0  0  0  0  0
##  [323]  0  1  1  0  0  0  1  1  0  0  0  0  0  0  1  1  0  2  2  2  0  0  0
##  [346]  0  0  0  0  0  0  1  1  1  1  0  0  0  0  0  1  1  0  0  0  1  1  0
##  [369]  1  1  1  0  1  1  0  0  0  0  1  1  0  0  0  0  0  1  0  0  0  0  0
##  [392]  1  1  0  0  0  0  0  0  1  1  1  1  0  0  0  1  1  0  0  0  0  0  1
##  [415]  1  0  0  0  0  1  1  0  0  0  0  0  0  1  0  0  0  0  0  0  0  1  1
##  [438]  1  1  1  1  0  2  2  2  1  2  2  0  1  0  1  1  0  0  1  1  0  0  1
##  [461]  2  0  2  2  0  0  1  1  0  0  0  0  0  0  0  1  1  0  1  1  1  1  0
##  [484]  0  0  0  0  0  1  1  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0
##  [507]  0  0  0  0  0  0  1  1  1  1  0  0  1  0  0  0  0  0  0  0  0  0  0
```

```
##   [530]  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  1  3  0  0  1  1  2  0
##   [553]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1
##   [576]  1  0  0  1  1  0  0  0  0  0  1  1  1  1  0  1  1  1  1  0  0  0  0
##   [599]  0  0  0  0  1  1  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
##   [622]  1  4  4  4  4  4  4  4  1  0  0  1  0  0  1  1  0  0  4  4  4  4  4
##   [645]  1  0  1  0  0  0  0  0  0  0  0  1  3  2  2  2  0  0  0  0  0  0  0
##   [668]  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  1  1  0  0  0  1  1
##   [691]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0
##   [714]  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0
##   [737]  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  2  0  2  2  1  1  1
##   [760]  1  0  0  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##   [783]  0  0  1  1  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0
##   [806]  0  2  2  0  2  1  1  0  0  0  0  0  0  0  0  0  1  0  1  0  5  5  5
##   [829]  5  5  5  1  1  0  0  0  0  2  2  0  0  0  1  1  1  1  0  0  2  1  0
##   [852]  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
##   [875]  0  0  0  1  1  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  1  1  0
##   [898]  0  0  0  1  1  1  1  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0
##   [921]  0  0  0  0  0  0  0  1  1  1  1  0  2  2  0  3  1  1  1  0  0  0  0
##   [944]  0  0  0  0  0  0  0  0  0  0  0  0  3  3  3  3  0  0  0  1  1  0  0  0
##   [967]  0  0  1  1  1  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##   [990]  0  0  0  0  0  0  0  0  0  0  0  0  0  2  2  2  0  0  0  0  0  0  1  1
##  [1013]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  1
##  [1036]  1  0  0  0  0  0  0  1  1  0  0  0  0  0  0  1  1  0  0  0  0  0  1  1
##  [1059]  0  0  0  0  0  0  0  0  0  0  0  0  1  0  1  0  0  0  0  0  0  0  0  0
##  [1082]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  3  3  0  4  4  4
##  [1105]  4  4  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  1  1  1  0  0  0  0
##  [1128]  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  4  4  4  4  4  0  0  0  0
##  [1151]  0  0  1  1  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  8  8  8
##  [1174]  8  8  8  8  8  8  1  1  0  0  0  2  2  2  1  0  1  0  0  0  0  0  0  0
##  [1197]  0  0  0  0  0  0  0  0  0  0  0  3  3  3  3  1  1  0  0  0  0  0  0  0
##  [1220]  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  1
##  [1243]  0  0  1  0  1  1  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  1  1  0
##  [1266]  0  1  1  0  0  0  0  0  2  3  2  1  0  0  0  0  0  0  0  0  0  0  0  0
##  [1289]  1  1  1  0  0  0  0  0  0  0  0  1  1  0  0  0  1  1  0  0  0 NA
##
## $parch
##     [1]  0  2  2  2  2  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  1  1  0
##    [24]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
##    [47]  0  0  0  1  1  0  0  0  2  2  2  2  0  0  0  0  0  0  0  0  0  0  0  0
##    [70]  1  0  0  0  0  0  0  1  1  2  0  0  1  2  1  0  0  0  0  0  0  2  0
##    [93]  0  1  2  1  0  1  0  0  0  0  1  0  0  0  0  0  0  0  0  0  2  2  2  2
##   [116]  4  4  0  0  0  0  0  2  1  1  0  0  0  0  0  1  1  0  0  0  0  0  0
##   [139]  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  1  1
##   [162]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##   [185]  0  0  0  1  1  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##   [208]  0  0  0  0  0  1  0  0  2  2  0  0  0  1  1  0  0  0  0  0  0  0  0  0
##   [231]  0  0  0  1  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  2  2  2  3
##   [254]  3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  1  1
##   [277]  0  0  0  0  0  0  0  0  0  0  0  0  0  2  1  1  0  0  1  2  1  0  0
##   [300]  0  0  0  0  0  0  0  1  1  0  2  1  1  1  2  1  0  1  1  0  0  0  0
##   [323]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1  3  0  0
##   [346]  0  0  0  0  0  2  1  1  0  0  0  0  0  0  2  1  1  0  0  0  0  0  0
##   [369]  0  0  1  2  0  0  0  0  0  2  1  1  0  0  0  0  0  1  0  2  0  0  0
##   [392]  0  0  0  0  1  1  0  2  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

```
##  [415]  0  0  0  0  0  0  0  0  0  0  0  0  0  1  2  0  1  1  0  0  2  1  1
##  [438]  2  2  2  2  0  0  0  0  1  1  1  0  3  0  0  0  0  0  0  0  0  0  0
##  [461]  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  2  2  2  2  0
##  [484]  0  0  0  0  0  0  0  0  0  2  1  1  0  0  0  0  0  0  1  1  0  0  0
##  [507]  0  0  0  0  0  0  0  0  1  1  2  0  1  0  0  0  0  0  0  0  0  0  0
##  [530]  1  0  0  0  1  0  1  0  0  0  0  1  1  2  0  0  0  0  0  1  1  3  0
##  [553]  0  0  0  0  0  1  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [576]  0  0  0  0  0  0  0  0  0  0  0  0  1  1  2  2  2  2  2  0  0  0  0
##  [599]  0  0  0  2  1  1  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0
##  [622]  0  2  2  2  2  2  2  2  5  0  0  5  0  0  0  0  0  0  2  2  2  2  2
##  [645]  5  0  5  0  0  0  0  0  0  0  0  0  0  1  1  1  3  0  0  0  0  1  1
##  [668]  0  0  0  0  0  0  0  0  0  0  0  1  1  0  2  2  1  1  0  0  0  0  0
##  [691]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [714]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  2
##  [737]  0  0  1  1  0  0  0  0  0  0  0  2  1  1  0  0  0  0  0  0  0  0  0
##  [760]  0  0  0  2  2  2  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [783]  0  0  0  0  0  0  0  0  2  1  1  0  0  0  0  0  0  0  0  0  0  0  0
##  [806]  0  2  2  0  2  3  3  0  0  0  0  0  0  0  0  2  1  0  1  0  2  2  2
##  [829]  2  2  2  6  6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [852]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0
##  [875]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0
##  [898]  0  0  2  2  2  2  2  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0
##  [921]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  1  1  1  1  2  0  0  0
##  [944]  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  4  0  0  0  0  0  0  0
##  [967]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [990]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [1013]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  1
## [1036]  1  2  0  0  0  0  0  0  0  0  0  0  0  0  2  1  1  0  0  0  0  0  0  0
## [1059]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [1082]  0  1  0  1  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  4  1  1  1
## [1105]  1  1  5  0  0  0  0  1  1  2  0  0  0  0  0  0  0  0  1  1  2  0  0  0
## [1128]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  1  5  0  0  0
## [1151]  0  0  0  0  0  0  1  1  2  0  0  0  0  0  0  0  0  0  0  0  0  2  2  2
## [1174]  2  2  2  2  2  2  9  9  0  0  0  0  0  0  0  1  2  1  0  0  0  0  0  0
## [1197]  0  0  0  0  0  0  0  0  0  0  0  2  2  2  2  4  4  0  0  0  0  0  0  0
## [1220]  0  0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  1  0
## [1243]  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  1  1  2  0  0  0  1  1  2
## [1266]  2  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [1289]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 NA
##
## $fare
##     [1] 211.3375 151.5500 151.5500 151.5500 151.5500  26.5500  77.9583
##     [8]   0.0000  51.4792  49.5042 227.5250 227.5250  69.3000  78.8500
##    [15]  30.0000  25.9250 247.5208 247.5208  76.2917  75.2417  52.5542
##    [22]  52.5542  30.0000 227.5250 221.7792  26.0000  91.0792  91.0792
##    [29] 135.6333  26.5500  35.5000  31.0000 164.8667  26.5500  26.5500
##    [36] 262.3750  55.0000  26.5500  30.5000  50.4958  39.6000  27.7208
##    [43]  51.4792  76.2917 134.5000  26.5500  31.0000  26.2875  27.4458
##    [50] 512.3292 512.3292   5.0000  47.1000  47.1000 120.0000 120.0000
##    [57] 120.0000 120.0000  26.0000  27.7208  78.8500  78.8500  61.1750
##    [64]  61.1750  53.1000  53.1000 262.3750  86.5000  29.7000  55.0000
##    [71]   0.0000 136.7792 136.7792 151.5500  52.0000  25.5875  83.1583
##    [78]  83.1583  83.1583  25.7000  26.5500  71.0000  71.0000  26.5500
##    [85]  71.2833  71.2833  26.5500  30.5000 151.5500  52.0000  52.0000
```

```
##   [92]  57.0000  57.0000  81.8583  81.8583  81.8583 106.4250 247.5208
##   [99] 106.4250  39.6000  56.9292  29.7000  83.1583 227.5250  78.2667
##  [106]  31.6792 221.7792  31.6833 110.8833  26.3875  27.7500 263.0000
##  [113] 263.0000 263.0000 263.0000 263.0000 263.0000  56.9292  26.5500
##  [120] 133.6500  27.7208 133.6500  49.5000  79.2000  79.2000   0.0000
##  [127]  53.1000  53.1000  38.5000 211.5000  59.4000  59.4000  79.2000
##  [134]  89.1042  89.1042  34.6542  28.5000  30.0000 153.4625 153.4625
##  [141]  63.3583  63.3583  79.2000  55.4417  55.4417  76.7292  76.7292
##  [148]  42.4000  83.4750  83.4750   0.0000  76.7292  30.0000  83.1583
##  [155]  93.5000  93.5000  42.5000  51.8625  50.0000  57.9792  57.9792
##  [162]  77.9583  52.0000  52.0000  26.5500  90.0000  30.6958  90.0000
##  [169]  80.0000  28.7125   0.0000  26.0000  26.0000 211.5000  29.7000
##  [176]  51.8625  51.8625  52.5542  52.5542  26.5500 211.3375  25.9292
##  [183] 106.4250 512.3292  27.7208  26.5500  27.7208  39.4000  39.4000
##  [190]  30.0000  77.9583  45.5000 146.5208 211.3375  26.0000  86.5000
##  [197]  29.7000  53.1000  53.1000  49.5042  75.2417  51.8625  26.2875
##  [204]  82.1708  82.1708  26.5500  90.0000  90.0000  90.0000  57.7500
##  [211]  30.5000  42.4000  29.7000 113.2750 113.2750 113.2750  26.2833
##  [218]  26.0000 108.9000  25.7417  61.9792  61.9792  27.7208   0.0000
##  [225]  28.5000  93.5000  66.6000  66.6000 108.9000 108.9000  93.5000
##  [232]  30.5000  52.0000  83.1583   0.0000  39.6000 135.6333 227.5250
##  [239] 211.3375  50.4958  26.5500  50.0000  27.7208  79.2000  40.1250
##  [246]  86.5000  59.4000  59.4000  26.5500 262.3750 262.3750 262.3750
##  [253] 262.3750 262.3750  30.5000  69.3000  26.0000  57.7500  31.0000
##  [260]  26.5500 153.4625  26.2875  55.9000  55.9000  35.5000  35.5000
##  [267]  26.5500  30.6958  60.0000  26.0000  60.0000  82.2667  82.2667
##  [274] 134.5000 134.5000 134.5000 146.5208 146.5208  30.5000  26.5500
##  [281]  55.4417  55.4417  78.2667  27.7208  80.0000 221.7792 221.7792
##  [288]  32.3208  25.9292  79.6500  79.6500  79.6500  52.0000  52.0000
##  [295] 110.8833 110.8833 110.8833  79.2000  28.5375  27.7208  33.5000
##  [302]  34.0208 512.3292  75.2500  75.2500  26.5500  77.2875  77.2875
##  [309] 135.6333 164.8667 164.8667 164.8667 211.5000 211.5000 211.5000
##  [316]  26.5500  61.3792  61.3792  35.0000 134.5000  35.5000  26.5500
##  [323] 135.6333  24.0000  24.0000  13.0000  11.5000  10.5000  26.0000
##  [330]  26.0000  13.0000  11.5000  10.5000  13.0000  10.5000  12.5250
##  [337]  26.0000  26.0000  26.0000  39.0000  39.0000  39.0000  39.0000
##  [344]  13.0000  13.0000  13.0000  13.0000  13.0000  13.0000  13.0000
##  [351]  39.0000  39.0000  39.0000  26.0000  26.0000  13.0000  13.0000
##  [358]  13.0000  13.0000  29.0000  29.0000  29.0000  21.0000   0.0000
##  [365]  13.0000  26.0000  26.0000  13.5000  26.0000  26.0000  30.0000
##  [372]  30.0000  26.0000  26.0000  10.5000  13.0000  10.5000  26.2500
##  [379]  26.2500  26.2500  10.5000  13.0000  21.0000  11.5000   0.0000
##  [386]  36.7500  73.5000  36.7500  13.0000  13.0000  73.5000  27.7208
##  [393]  27.7208  31.5000  73.5000  23.0000  23.0000  26.0000  32.5000
##  [400]  32.5000  32.5000  13.8583  13.8583  13.0000  13.0000  13.0000
##  [407]  26.0000  26.0000  10.5000  13.0000   0.0000  13.0000  26.0000
##  [414]  21.0000  21.0000  13.0000  26.0000  10.5000  10.5000  11.5000
##  [421]  11.5000  13.5000  13.0000  13.0000  13.0000  13.0000  13.0000
##  [428]  14.5000  14.5000  13.0000  33.0000  33.0000  10.5000  10.5000
##  [435]  26.2500  26.2500  26.2500  65.0000  65.0000  65.0000  65.0000
##  [442]  16.0000  73.5000  73.5000  73.5000  13.0000  23.0000  11.5000
##  [449]  13.0000  23.0000  13.0000  26.0000  26.0000  73.5000  13.0000
##  [456]  26.0000  26.0000  12.2750  10.5000  27.0000  27.0000  15.0000
##  [463]  31.5000  31.5000  10.5000  13.7917  26.0000  26.0000  21.0000
```

```
##  [470] 12.3500 12.3500 13.5000 12.3500  0.0000 10.5000 26.0000
##  [477] 26.0000 10.7083 41.5792 41.5792 41.5792 41.5792 12.0000
##  [484] 33.0000 10.5000 12.8750 10.5000 12.3500 26.0000 26.0000
##  [491] 10.5000 15.0458 37.0042 37.0042 37.0042 15.5792 13.0000
##  [498] 16.0000 13.5000 13.0000 26.0000 19.5000 19.5000 10.5000
##  [505] 13.0000 13.0000 10.5000 13.0000 14.0000 26.0000 10.5000
##  [512]  9.6875 30.0708 30.0708 26.0000 26.0000 26.0000 13.0000
##  [519] 36.7500 13.5000 13.8625 10.5000 13.0000 10.5000 13.8625
##  [526] 10.5000 13.8583 10.5000  0.0000 26.0000 10.5000 15.0500
##  [533] 13.0000 21.0000 26.0000 21.0000 13.0000 13.0000 12.7375
##  [540] 15.0333 26.0000 26.0000 26.0000 10.5000 21.0000 21.0000
##  [547] 13.0000 15.0458 18.7500 18.7500 18.7500 10.5000 10.5000
##  [554] 10.5000 13.0000 13.0000 26.0000 26.0000 13.0000 36.7500
##  [561] 13.0000 13.5000 12.3500 10.5000 13.0000 13.0000 15.0458
##  [568] 10.5000 13.0000 65.0000 10.5000 13.0000 12.6500 10.5000
##  [575] 21.0000 21.0000 13.0000 21.0000 21.0000 10.5000 21.0000
##  [582]  0.0000 15.7500 15.7500 13.0000 26.0000 26.0000 23.0000
##  [589] 23.0000 23.0000 27.7500 27.7500 27.7500 27.7500 10.5000
##  [596] 12.8750 13.0000 13.0000 13.5000 13.0000  7.5500 20.2500
##  [603] 20.2500 20.2500  7.6500  7.6500  7.9250  7.2292  7.2500
##  [610]  8.0500  9.4750  9.3500  9.3500 18.7875  7.8875  7.9250
##  [617]  7.0500  7.0500  8.0500  8.3000 22.5250  7.8542 31.2750
##  [624] 31.2750 31.2750  7.9250  7.7750 31.2750 31.2750 31.2750
##  [631]  7.7958  7.7750 31.2750  7.8542  7.8958 17.8000 17.8000
##  [638]  7.7750  7.0500 31.3875 31.3875 31.3875 31.3875 31.3875
##  [645] 31.3875  7.7958 31.3875  7.2250  7.2250  7.0500 14.4583
##  [652]  7.2250  7.8542  7.2292  7.2250 15.8500 15.8500 19.2583
##  [659] 19.2583 19.2583 19.2583  8.0500  7.2250  7.8958  7.2292
##  [666] 14.4542 14.4542  7.8792  8.0500  8.0500  7.7750  9.3500
##  [673]  7.2292  4.0125 56.4958  7.7750  7.7500  7.8958 15.2458
##  [680] 15.2458  7.2250 15.2458  7.7500 15.5000 15.5000 16.1000
##  [687]  7.7250  7.8542  7.0458  7.2500  7.7958  8.0500  7.2833
##  [694]  7.8208  6.7500  7.8792  8.6625  8.6625  8.6625  8.6625
##  [701]  8.6625  8.6625  7.7500  7.7500  8.0500 14.4583 14.4583
##  [708]  7.7958  7.8542  7.7500  7.7500  7.2500  8.0500  7.7333
##  [715] 56.4958  8.0500 14.4542 14.4542  7.0500  8.0500  7.2500
##  [722]  7.4958  7.4958  7.7333  7.7500  7.7500  7.6292  7.7500
##  [729]  8.0500  7.8958  7.8958  7.8958  8.0500 15.9000 15.9000
##  [736] 15.9000  7.2500  8.1583 16.1000 16.1000  8.6625  7.2250
##  [743]  8.0500 10.5167 10.1708  6.9500  7.7500 14.4000 14.4000
##  [750] 14.4000  7.8958  7.8958 24.1500  8.0500 24.1500  8.0500
##  [757] 16.1000 16.1000 17.4000 17.4000  9.5000  9.5000 20.5750
##  [764] 20.5750 20.5750 20.5750  7.8958  7.8958  7.8958  7.2500
##  [771]  7.2500  7.8792  7.8958  8.6625  7.8958  7.2292  7.7500
##  [778]  8.0500 12.4750  7.7500  8.0500  7.8958  7.7500  7.5500
##  [785] 13.9000 13.9000  7.7750  7.7750  6.9750  7.2250  7.2292
##  [792]  7.2292  7.2292  7.2500 12.4750  7.2250 15.1000  7.7500
##  [799]  7.0500  7.7958  7.7500  7.7500  6.9500  7.8792  7.7500
##  [806] 56.4958 34.3750 34.3750  8.0500 34.3750 34.3750 34.3750
##  [813]  7.7500  7.2500  7.7417 14.5000  7.8958  8.0500  7.7333
##  [820]  7.7500 20.5250 20.5250  7.8500 20.5250  7.0500 46.9000
##  [827] 46.9000 46.9000 46.9000 46.9000 46.9000 46.9000 46.9000
##  [834]  8.0500  8.3625  8.0500  9.8458  7.9250  7.9250  7.7750
##  [841]  8.8500  7.7333 19.9667 19.9667 15.8500 15.8500  9.5000
```

```
##  [848]   7.2292  14.1083   7.8542   7.8542  14.1083   7.5500   7.2500
##  [855]   6.8583  18.7875   7.7500   6.9750  56.4958   6.7500   7.9250
##  [862]   7.9250   8.9625   7.8958   7.7750   7.7500  12.2875  12.2875
##  [869]   6.4500  22.5250   7.9250   7.7500   8.0500   7.6500   7.8875
##  [876]   7.2292   7.8958   7.9250   7.9250   7.8958   7.8958   7.7958
##  [883]   7.0500   7.8542   7.8542   7.0542   7.7500   8.1125   6.4958
##  [890]   7.7750   7.7958   8.6542   7.7750   7.8542  11.1333  11.1333
##  [897]   0.0000   7.7750   0.0000  11.1333  23.4500  23.4500  23.4500
##  [904]  23.4500   7.8958   7.8542   7.8542   9.8250   9.8250   7.9250
##  [911]   7.1250   8.4333   7.8958   7.7958   7.8542   7.5208  13.4167
##  [918]  13.4167   7.2292   7.2292   7.7500   7.2500   7.7500   7.7500
##  [925]   7.8292   8.0500   7.7500  14.4542  14.4542   7.7500   7.7500
##  [932]   7.7375   8.6625   8.6625  22.0250  22.0250  22.0250  12.1833
##  [939]   7.8542  12.1833   7.8958   7.2292   7.2250   9.5875   7.8958
##  [946]  56.4958  56.4958   7.2500   7.7500  56.4958   9.4833   7.7750
##  [953]   7.7750   7.2250  25.4667  25.4667  25.4667  25.4667  25.4667
##  [960]   7.9250   6.4375  15.5000  15.5000   0.0000  24.1500   9.5000
##  [967]   7.7750   7.7500  15.5500  15.5500   7.9250   7.8792  56.4958
##  [974]   7.5500  16.1000  16.1000   7.8792   7.2500   8.6625   7.0542
##  [981]   7.8542   7.5792   7.8958   7.5500   7.7500   7.1417   7.1250
##  [988]   7.8792   7.7500   8.0500   7.9250   7.2292   7.7500   7.7375
##  [995]   7.2292   7.8958   7.8958   7.2250   7.8958   7.7500   7.7500
## [1002]  23.2500  23.2500  23.2500   7.7875  15.5000   7.8792   8.0292
## [1009]   7.7500   7.7500  16.1000  16.1000   7.7500   8.0500   8.0500
## [1016]   8.0500   7.7500   7.7750   8.0500   7.8958   7.8958   7.8958
## [1023]   7.8958   7.8792   7.6500  12.4750  12.4750   8.0500  24.1500
## [1030]  24.1500   8.4583   8.0500   7.7500   7.7750  15.2458  15.2458
## [1037]  15.2458   7.2292   8.0500   7.7333   7.7500   8.0500  15.5000
## [1044]  15.5000  15.5000   7.7500   7.8958   7.2250  15.7417  15.7417
## [1051]  15.7417   8.0500   7.8958   7.2292   7.7500   7.8958  11.2417
## [1058]  11.2417   7.9250   8.0500   7.7750   7.8542   7.8542   7.1250
## [1065]   7.9250   7.8000   7.2292   7.7500   6.2375  15.5000   7.8292
## [1072]  15.5000   7.7333   7.7500   7.7500   9.2250   7.7500   7.7500
## [1079]   7.8792   7.7750   7.7500   7.8292   3.1708  22.5250   8.4042
## [1086]   7.3125   7.8542   7.8542   7.7750   9.2250   8.6625   8.6625
## [1093]   8.6625   9.2167   8.6833   7.6292  21.0750  21.0750  21.0750
## [1100]  21.0750  21.0750  39.6875  39.6875  39.6875  39.6875  39.6875
## [1107]  39.6875   8.6625  14.5000   8.7125   7.8958  13.7750  13.7750
## [1114]  13.7750   7.0000   7.7750   8.0500   7.9250   7.9250   7.2500
## [1121]   7.7750  22.3583  22.3583  22.3583   8.1375   8.0500   7.8958
## [1128]   7.8958   7.8958   7.7750   7.7750   8.0500   7.8958   8.6625
## [1135]   8.6625   7.8958   8.1125   7.2292   7.2500   7.8958   8.0500
## [1142]  29.1250  29.1250  29.1250  29.1250  29.1250  29.1250  39.6875
## [1149]   7.1250   7.7208  14.5000  14.5000  14.5000  14.5000   8.0500
## [1156]   7.7750  20.2125  20.2125  20.2125   8.0500   8.0500   8.0500
## [1163]   7.7500  24.1500   7.2292   7.2250   7.2250   7.7292   7.5750
## [1170]   7.2500  69.5500  69.5500  69.5500  69.5500  69.5500  69.5500
## [1177]  69.5500  69.5500  69.5500  69.5500  69.5500   9.3250   7.6500
## [1184]   7.9250  21.6792  21.6792  21.6792  16.7000  16.7000  16.7000
## [1191]   9.5000   8.0500   8.0500   7.7250   7.8958   7.7500   9.5000
## [1198]  15.1000   7.7792   8.0500   8.0500   7.2292   8.0500   7.8958
## [1205]   7.9250   7.4958  27.9000  27.9000  27.9000  27.9000  27.9000
## [1212]  27.9000   7.8958   8.0500   8.6625   7.7500   7.7333   7.6500
## [1219]   8.0500   8.0500   8.0500   7.8958   8.6625   7.5500   8.0500
```

```
## [1226]       NA   7.8958   9.8375   7.9250   8.6625  10.4625  10.4625
## [1233]   8.0500   7.9250   7.0500   7.7750   9.2250   7.7958   7.7958
## [1240]   8.0500   8.5167   6.4375   6.4375   7.2250   8.5167   8.0500
## [1247]  16.1000  16.1000   7.9250   7.7500   7.8958   8.0500   8.0500
## [1254]   7.2292   0.0000   7.2292  15.2458  15.2458  15.2458   7.8958
## [1261]   9.8417   9.5875  14.5000  14.5000  14.5000  24.1500  24.1500
## [1268]  24.1500   9.5000   9.5000   9.5000   9.5000   9.0000  18.0000
## [1275]  18.0000  18.0000  18.0000   7.2250   7.8542   7.8542   7.8958
## [1282]   9.0000   8.0500   7.5500   8.0500   9.5000   7.2292   7.7500
## [1289]   6.4958   6.4958   7.0000   8.7125   7.5500   8.0500  16.1000
## [1296]   7.2500   8.6625   7.2500   9.5000  14.4542  14.4542   7.2250
## [1303]   7.2250  14.4583  14.4542  14.4542   7.2250   7.2250   7.8750
## [1310]       NA
##
## $embarked
##    [1] S S S S S S S S C C C C S S S C C C C S S C C S C C C S S S C S S
##   [35] S C S S S C C C S C C S S S C C C S S S S S S S S C S S S S S S C S
##   [69] C S S C C S S S S C C C S S S S S S C C S S S S S S S S S S C C C C C C
##  [103] C C C C S S C S C S S S S S S C S S C S C C C S S S S C C C C C C C
##  [137] C S S S C C C C C C C S S S S C S C S S S S S C C S S S S C S C S   C
##  [171] S S S C C S S S S S S S C C C S C S S S S S C S S S C S S S C C S S C
##  [205] C S Q Q Q C S S S C C C C S S S C C C C C S S S S S C C S S S C S S C C
##  [239] S S S S C C C S C C S S C C C C C S C S C C S S S S S S C S S S C S S S S
##  [273] S C C C C C C C S C C C C   S S S S S S S S S C C C C C C S S C C C S
##  [307] S S C S S S S C C C S C C S C S S S C C C S S S S S S S S S S S S S S S
##  [341] S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S
##  [375] S S S S S S S S S S S S S S S S S C C S S S S S S S S C C S S S S S S
##  [409] S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S
##  [443] S S S S S S S S S S S S S S S S S S S S S S S S S C S S S S Q Q S Q S S S
##  [477] S Q C C C C C S S C S Q S S S C C C C C S S S S S S S S S S S S S S S S
##  [511] S Q C C S S S S S S C S S S C S C S S S S C S S S S S S S C C S S S S S
##  [545] S S S C S S S S S S S S S S S S S S Q S S S S C S S S S S S S S S S S S
##  [579] S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S C S S S S
##  [613] S C S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S
##  [647] S C C S C C S C C S S C C C C S C S C C C Q S S S S C C S S S S C C
##  [681] C C Q Q Q S Q S S S S S Q Q Q Q S S S S S S Q Q S C C S S Q Q S S Q
##  [715] S S C C S S Q S S Q Q Q Q Q S S S S S S S S S S S S S S C S S S Q Q S
##  [749] S S S S S S S S S S S S S S S S S S S S S S S S S Q S S S S C Q S S Q S C
##  [783] Q S S S S S S C C C C S S C S Q S S Q Q Q Q Q S S S S S S S S Q S Q S
##  [817] C S Q Q S S S S S S S S S S S S S S S S S S S S S S S Q S S S S S C S S
##  [851] S S S S Q C Q S S Q S S S S S Q S S S S S Q S S S S C S S S S S C S S S
##  [885] S S Q S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S C C
##  [919] C C Q S Q Q Q S Q C C Q Q Q S S S S S S S S C C C S S S S S S Q S S S
##  [953] S C S S S S S S S C Q Q S S S S S S S S S Q S S S S S S S S S S S S S Q S
##  [987] S Q Q S S C Q Q C C S C C Q Q Q Q Q Q Q Q Q Q Q S S Q S S S Q S S S
## [1021] S S S Q S S S S Q Q Q S Q S C C C C S Q Q S Q Q Q S S C C C C S S C
## [1055] Q S C C S S S S S S S S S C S S Q Q Q Q Q S Q Q Q S Q Q S S S S S S
## [1089] S S S S S S S Q S S S S S S S S S S S S S C S S S S S S S S S S S C
## [1123] C C Q S S S S S S S S S S S C S S S Q Q Q Q Q S S Q S S S S S S
## [1157] S S S S S S Q Q C C C Q S S S S S S S S S S S S S S S S S C C C S S S
## [1191] S S S Q S Q S S Q S S C S S S S S S S S S S S S S S Q Q S S S S S C S
## [1225] S S S S S S S S S S S S S S S S C C C C C S S S S Q S S S C S C C C
## [1259] C S S S S S S S S S S S S S S S S S S C S S S S S S S S C S S S S S
## [1293] S S S S S S S C C C C C C C C C S
```

```
## Levels:  C Q S
##
## $survived01
##    [1] 1    1    0    0    0    1    1    0    1    0    0    1    1
##   [14] 1    1    0    0    1    1    0    1    1    1    1    1    0
##   [27] 1    1    1    1    0    1    1    1    0    1    1    1    0
##   [40] 0    0    1    1    1    1    0    0    1    1    1    1    0
##   [53] 0    0    1    1    1    1    0    1    0    1    0    1    1
##   [66] 1    1    1    1    1    0    0    1    1    0    0    1    0
##   [79] 1    1    0    0    1    1    0    1    1    1    1    0    1
##   [92] 1    1    1    1    1    0    1    1    1    1    0    1    1
##  [105] 1    0    0    1    1    1    0    1    1    1    0    0    1
##  [118] 1    0    1    1    1    1    1    1    0    0    1    0    1
##  [131] 1    1    0    1    1    0    1    1    0    1    1    1    0
##  [144] 1    1    1    1    0    0    1    0    1    1    1    0    1
##  [157] 0    0    0    1    1    1    0    1    1    1    0    1    1
##  [170] 0    1    0    0    0    0    0    1    1    1    0    1    1
##  [183] 1    1    0    0    1    1    1    0    1    0    1    1    0
##  [196] 1    1    0    1    1    0    0    1    0    1    0    0    1
##  [209] 1    1    0    0    0    1    1    0    1    0    1    1    1
##  [222] 0    0    0    0    0    0    1    0    1    1    1    0    1
##  [235] 0    1    0    0    1    0    1    0    1    0    0    1    0
##  [248] 1    0    1    1    1    0    1    1    1    1    1    1    1
##  [261] 1    1    0    1    1    1    0    0    0    0    1    1    1
##  [274] 1    1    1    0    1    1    0    1    1    1    0    1    0
##  [287] 0    0    1    1    0    1    1    1    0    1    1    1    1
##  [300] 0    0    0    1    0    1    0    0    0    1    1    0    1
##  [313] 0    0    1    1    0    1    0    1    1    0    1    0    1
##  [326] 0    0    0    0    1    0    0    0    1    0    0    1    1
##  [339] 0    1    1    1    1    1    1    0    0    0    0    1    1
##  [352] 0    1    1    0    1    0    0    1    1    1    1    1    0
##  [365] 0    0    0    0    0    0    1    1    0    1    0    0    1
##  [378] 1    0    1    1    0    0    0    0    1    0    1    1    0
##  [391] 0    0    1    0    0    1    1    0    1    0    1    1    1
##  [404] 0    0    0    0    1    0    0    0    0    0    0    0    1
##  [417] 0    0    0    0    0    0    0    0    0    0    0    1    1
##  [430] 0    1    0    1    0    1    0    1    1    1    0    1    1
##  [443] 0    0    0    0    1    0    0    1    0    0    1    0    1
##  [456] 0    0    0    1    0    1    0    0    0    0    1    0    1
##  [469] 0    1    0    1    0    0    0    0    0    0    1    1    0
##  [482] 1    1    1    1    0    0    0    0    1    0    0    1    0
##  [495] 1    0    0    0    0    0    0    1    1    1    0    0    0
##  [508] 0    0    0    0    0    0    1    1    1    0    0    0    0
##  [521] 1    1    0    1    1    0    1    0    0    1    0    0    0
##  [534] 1    1    0    1    0    1    0    1    1    1    0    0    1
##  [547] 1    0    1    1    1    1    0    1    0    0    0    1    1
##  [560] 1    1    0    1    0    1    0    0    0    0    0    1    0
##  [573] 1    1    0    0    0    1    0    0    1    0    1    1    1
##  [586] 0    1    1    1    1    1    1    0    1    0    0    1    1
##  [599] 1    0    0    0    0    1    1    1    1    1    0    0    0
##  [612] 1    1    1    0    0    0    0    0    0    0    1    0    0
##  [625] 0    1    0    0    0    0    1    0    0    0    0    0    0
##  [638] 0    0    0    0    1    0    1    0    1    1    1    0    0
##  [651] 0    0    0    1    0    0    1    1    1    1    1    1    0
```

```
##  [664] 0    1    0    0    0    0    0    0    0    0    0    1    0
##  [677] 0    0    0    0    0    0    0    0    0    0    1    0    0
##  [690] 0    0    0    0    1    0    0    0    0    0    0    0    0
##  [703] 0    0    0    0    0    0    0    1    0    0    0    0    1
##  [716] 0    0    0    0    1    0    0    0    0    0    1    0    0
##  [729] 0    0    0    0    0    1    1    1    0    0    1    0    0
##  [742] 0    1    0    0    1    1    0    0    0    0    0    0    0
##  [755] 0    0    0    1    1    1    1    0    1    1    0    1    0
##  [768] 0    0    0    0    1    0    0    0    0    0    1    1    0
##  [781] 1    0    0    1    0    1    0    0    0    0    0    0    0
##  [794] 0    1    0    0    0    1    0    0    0    0    0    0    1
##  [807] 0    0    0    0    0    0    0    0    0    0    0    0    1
##  [820] 1    1    0    0    1    0    0    0    0    0    0    0    0
##  [833] 0    0    0    0    0    0    0    0    0    0    0    0    0
##  [846] 1    0    0    0    0    0    1    0    0    0    0    1    1
##  [859] 1    0    1    0    1    0    0    0    1    1    0    0    1
##  [872] 0    1    0    1    0    0    0    0    0    1    1    0    0
##  [885] 0    0    1    1    0    1    0    0    0    0    1    1    0
##  [898] 0    0    1    0    0    0    0    0    1    0    0    0    1
##  [911] 0    0    0    1    0    0    1    1    0    0    0    0    1
##  [924] 1    0    0    1    0    0    0    0    0    0    0    1    1
##  [937] 1    0    0    0    0    1    0    0    0    1    0    1    0
##  [950] 1    0    0    0    1    0    0    0    0    0    0    0    0
##  [963] 0    0    0    0    0    0    0    0    1    0    0    0    0
##  [976] 0    0    0    1    0    1    1    0    0    1    1    0    0
##  [989] 0    0    0    1    0    1    0    0    0    1    0    1    1
## [1002] 1    1    1    1    0    1    1    0    0    0    0    0    0
## [1015] 0    0    0    1    0    0    0    0    0    1    0    1    1
## [1028] 0    1    0    0    0    0    1    1    1    1    1    0    1
## [1041] 1    0    1    1    1    0    0    1    1    1    1    0    0
## [1054] 0    0    0    1    1    0    0    1    1    0    0    1    0
## [1067] 0    1    0    0    0    1    0    0    0    0    0    1    1
## [1080] 1    1    1    1    0    0    0    0    0    1    0    0    0
## [1093] 0    0    1    0    0    0    0    0    0    0    0    0    0
## [1106] 0    0    0    0    0    0    0    0    0    0    0    0    0
## [1119] 0    0    1    1    1    1    0    0    0    0    0    0    0
## [1132] 1    0    0    0    0    0    0    0    0    0    0    0    0
## [1145] 0    0    0    0    0    1    0    0    0    0    0    0    0
## [1158] 0    0    1    0    0    1    0    0    0    0    0    0    0
## [1171] 0    0    0    0    0    0    0    0    0    0    0    0    1
## [1184] 0    0    0    0    1    1    1    1    0    0    0    0    0
## [1197] 1    0    1    0    0    0    0    0    0    1    0    0    0
## [1210] 0    0    0    0    0    0    0    1    0    0    0    0    0
## [1223] 0    1    0    0    0    0    1    0    0    0    1    1    0
## [1236] 0    1    0    1    0    1    0    0    0    1    0    0    1
## [1249] 0    0    0    0    0    0    1    0    1    1    1    0    1
## [1262] 1    0    0    0    0    0    0    0    0    0    0    0    0
## [1275] 0    0    0    1    0    0    0    0    0    0    0    0    1
## [1288] 0    0    0    1    0    0    0    0    0    0    0    0    0
## [1301] 1    0    0    0    0    0    0    0    0    <NA>
## Levels: 0 1
```

Part 2: Build a forest

To use the random forest model, we will need to load the relevant library.

```
# install package
library(randomForest)
```

```
## Warning: package 'randomForest' was built under R version 3.3.2
```

```
## randomForest 4.6-12
```

```
## Type rfNews() to see new features/changes/bug fixes.
```

```
##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:dplyr':
##
##     combine
```

Random forest can use only complete records. We will removed any observation that does not have values for all the predictor and target variables.

```
# remove rows with missing data
titanic.clean <- na.omit(titanic3)
```

Part 3: Split the data

We can now split the data into training and test sets.

```
set.seed(1)

# split the data in half

# indices
train_index <- sample(nrow(titanic.clean), nrow(titanic.clean)/2)

# assign data
train <- titanic.clean[train_index, ]
test <- titanic.clean[-train_index, ]
```

We can also assign a couple of new variables, which will be the expected result from the test set. These can be used to construct the confusion matrix.

```
# target variable from text set
actual <- titanic.clean[-train_index, "survived"]

actual01 <- titanic.clean[-train_index, "survived01"]
```

Part 4: Build random forest model with numeric target variable

We will now build a regression random forest model with survived as the target. We will use all other variables, except survided01, as predictors.

```
set.seed(1)

rf.titanic <- randomForest(survived ~ . -survived01, data = train, mtry = 7,importance=TRUE)
```

```
## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?
```

We can now used the model to predict probabilities.

```
prediction <- predict(rf.titanic, newdata = test)
```

We can compare the predicted and actual results to compute the test error. First we will convert the probabilities to classes.

```
titanic.class = ifelse(prediction <= 0.5, "0", "1")
```

Now we can compare the results.

```
mean(titanic.class != actual)
```

```
## [1] 0.2619503
```

Additionally we can get some stats on the model.

```
# stats
rf.titanic
```

```
##
## Call:
##  randomForest(formula = survived ~ . - survived01, data = train,      mtry = 7, importance = TRUE)
##                Type of random forest: regression
##                      Number of trees: 500
## No. of variables tried at each split: 7
##
##           Mean of squared residuals: 0.1568015
##                     % Var explained: 35.27
```

Part 5: Part 5: Random forest model with categorical variable as target

Now We will now build a classification random forest. We will use survided01 as the target, and all other variables, with the execption of survived, being used as predictors.

```
rf.titanic01 <- randomForest(survived01 ~ . -survived, data = train, mtry = 7,importance=TRUE)
```

We can now used the model to predict probabilities, with the test dataset. We can assign the prediction to classes, instead of raw probabilities.

```
prediction01 <- predict(rf.titanic01, newdata = test, type="class")
```

Now we can compare the results.

```
mean(prediction01 != actual01)
```

```
## [1] 0.2657744
```

We can also get model statistics, directly from the model as it is a classification model.

```
# stats
rf.titanic01
```

```
##
## Call:
##  randomForest(formula = survived01 ~ . - survived, data = train,      mtry = 7, importance = TRUE)
##                Type of random forest: classification
##                      Number of trees: 500
```

```
## No. of variables tried at each split: 7
##
##         OOB estimate of  error rate: 22.03%
## Confusion matrix:
##     0   1 class.error
## 0 254  53   0.1726384
## 1  62 153   0.2883721
```

```
# number of tree
rf.titanic01$ntree
```

```
## [1] 500
```

```
# error
mean(rf.titanic01$err.rate)
```

```
## [1] 0.2306939
```

Part 6: Variable Importance Plot

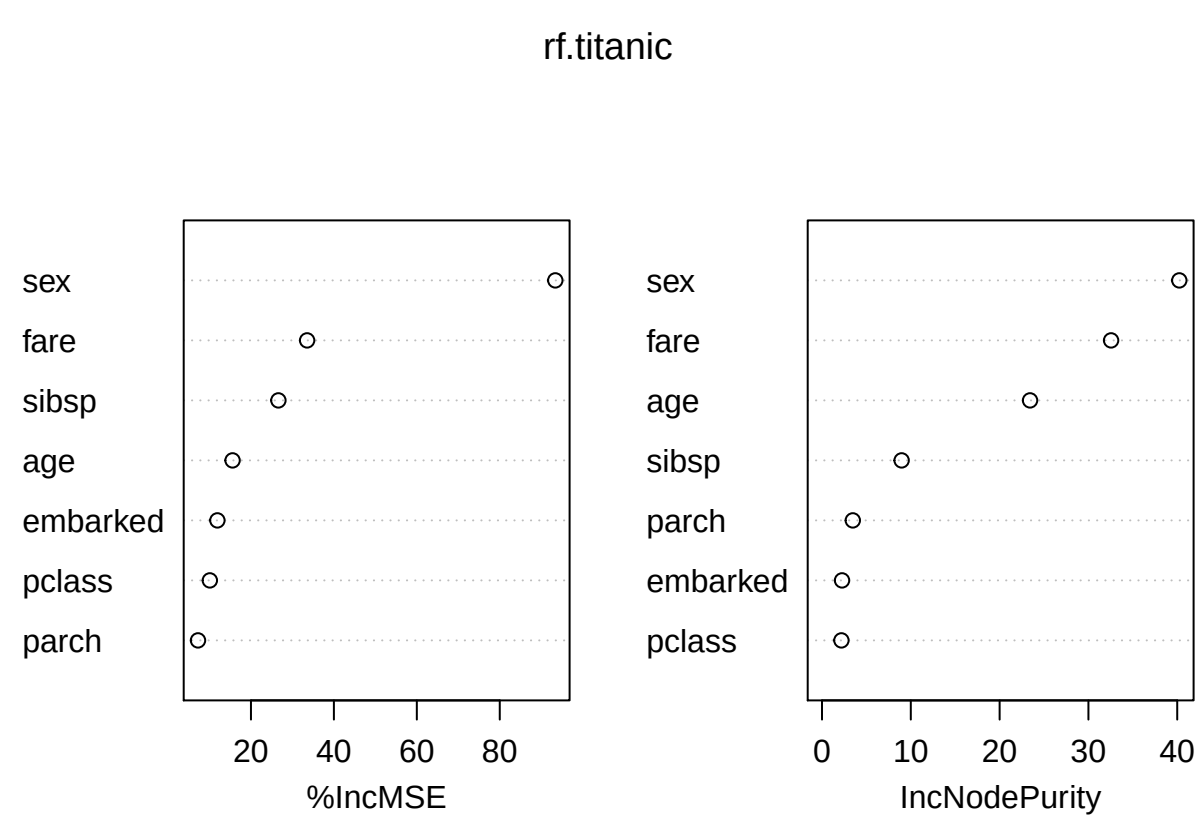
We can analysis and plot the importance of each predictor variable in a random forest. For the regression model:

```
# Regression Model

importance(rf.titanic)
```

```
##            %IncMSE IncNodePurity
## pclass   10.087955      2.186815
## sex      93.397510     40.233261
## age      15.564187     23.426733
## sibsp    26.618759      8.964820
## parch     7.232629      3.467468
## fare     33.546175     32.552171
## embarked 11.907694      2.255054
```

```
varImpPlot(rf.titanic)
```



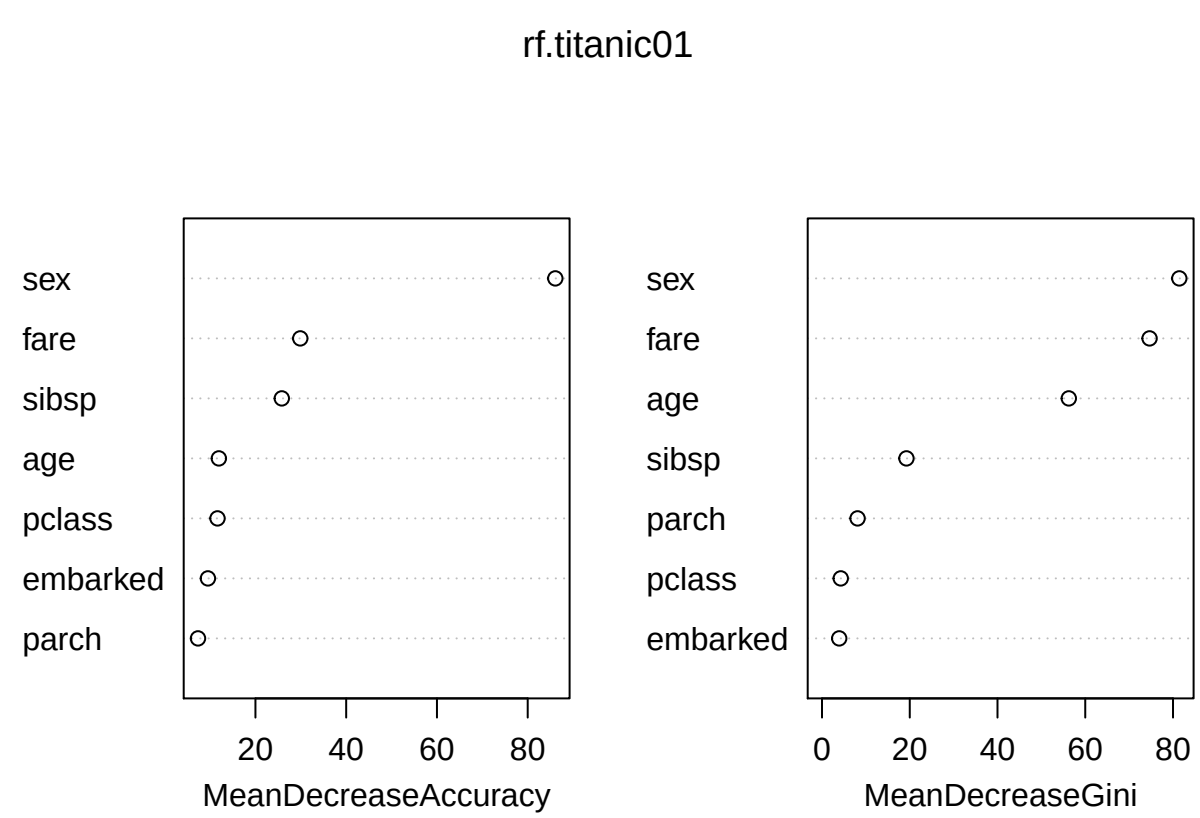
For the classification model:

```
# Classification Model

importance(rf.titanic01)
```

```
##                 0         1 MeanDecreaseAccuracy MeanDecreaseGini
## pclass    9.985365  6.227571            11.637846         4.273848
## sex      57.207633 70.264456            86.083768        81.436346
## age      14.797445 -1.011604            11.938175        56.251740
## sibsp    26.488531  3.088241            25.807837        19.245102
## parch     4.381573  6.295932             7.342782         8.106748
## fare     17.416184 26.226156            29.877324        74.657358
## embarked  8.840642  4.639516             9.525474         3.920659
```

```
varImpPlot(rf.titanic01)
```



Part 7: Comparison of Error Rates

We can compare the error rate from different modelling approaches. For this comparison, we will use a forest comprising of 200 tree.The first will use a majority vote from all the tree in the forest to decided a classification.

```
# The black line (majority vote)

# vector for test error
error.mv = rep(0,200)

for (i in 1:200){

  set.seed(1)

  # new classification model
  rf.titanicC <- randomForest(survived01 ~ . -survived, data = train, mtry = 7,importance=TRUE, ntree =

  # get predictions
  predictionC <- predict(rf.titanicC, newdata = test, type = "class")

  error.mv[i] <- mean(predictionC != actual01)
}
```

The second approach uses averages probabilities from each tree and predicts the class with the highest value.

```
# blue line

# vector for test error
error.ave = rep(0,200)

for (j in 1:200){


  set.seed(1)
  # new classification model
  rf.titanicR <- randomForest(survived ~ . -survived01, data = train, mtry = 7,importance=TRUE, ntree =

  # get predictions
  predictionR <- predict(rf.titanicR, newdata = test)

  predctionR.class = ifelse(predictionR<=0.5, "0", "1")

  error.ave[j] <- mean(predctionR.class != actual)
}
```

```
## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
```

```
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?

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```
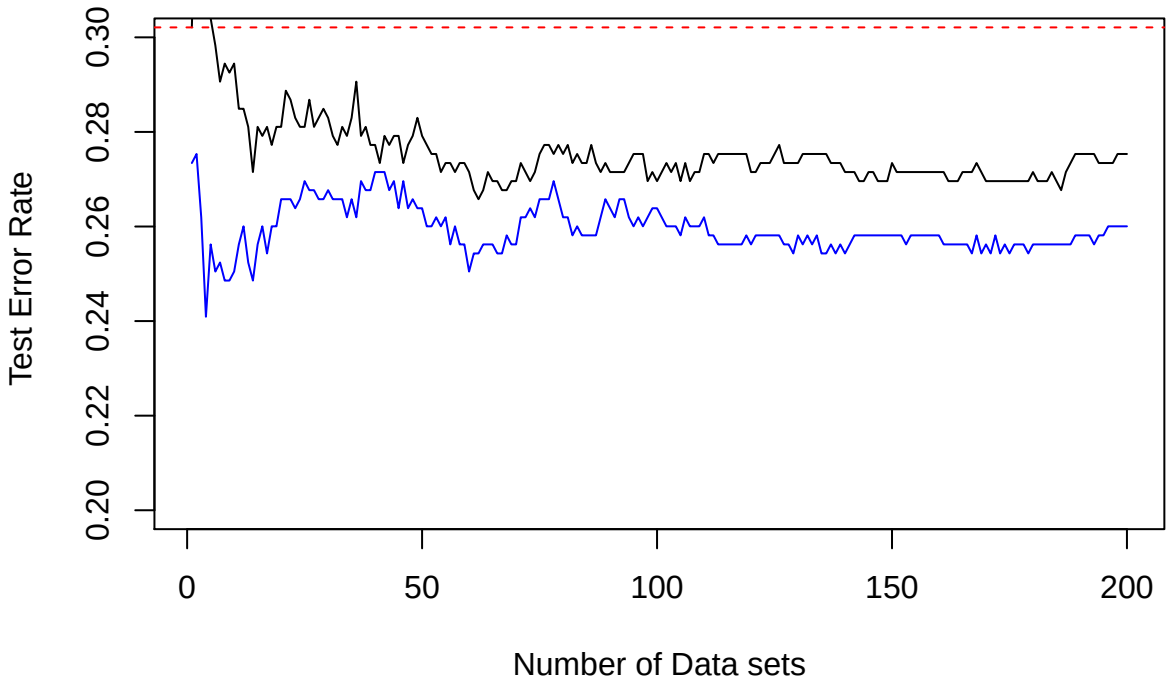

We can now plot all both of the results against the error from a single tree.

```
# black line
plot(error.mv, xlab="Number of Data sets", ylab="Test Error Rate ", type="l"
     , ylim= c(0.2, 0.3))

#blue line
lines(error.ave, col="blue")

# add red line
abline(h=error.mv[1],lty=2,col="red")
```



Part 8: Experiments with number of predictors at tree splits

We can now experiment with different values for mtry, to try and reduce the error.

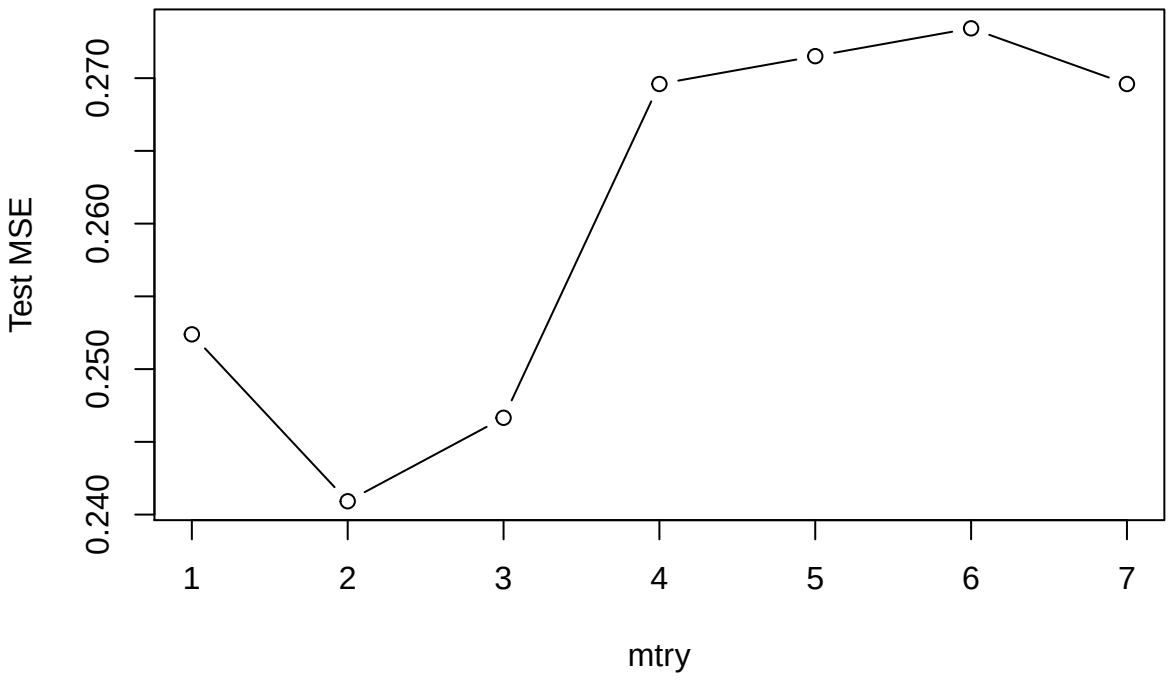
```
error.preds <- rep(0,7)
```

We will build 7 different forests, each with a different number of possible splits (1-7) at each branch.

```
for (i in 1:length(error.preds)){

  rf.titanicM <- randomForest(survived01 ~ . -survived, data = train, mtry = i,importance=TRUE)

  predictionM <- predict(rf.titanicM, newdata = test, type="class")

  error.preds[i] <- mean(predictionM != actual01)

}
```

We can plot the results.

```
plot(error.preds, type="b", xlab="mtry", ylab="Test MSE")
```



Part 9: Errors vs ntrees

We will now experiment by altering the number of tree in each forest, and compare these with different values for mtry. We can visualise the results with a plot.

```
plot(0,ylab="Test Error", xlab="Number of Trees", main="Random Forest", xlim=c(1,540), ylim =c(0.17,0.3

errors.trees <- matrix(nrow=7, ncol=500 )

for (i in 1:7){


  for (j in 1:500) {

    set.seed(1)

    rf.titanicLoop <- randomForest(survived01 ~ . -survived, data = train, mtry = i,ntree = j ,importan

    predictionLoop <- predict(rf.titanicLoop, newdata = test, type="class")

    errors.trees[i, j] <- mean(predictionLoop!= actual01)

  }

  lines(errors.trees[i, ],col=i,type="l")
```

```
}

legend(title="mtry","bottomright",c("1","2","3","4","5","6","7"),lty=rep(1,7),col=1:7)
```