

# Titanic\_with\_R

June 23, 2016

## 1 Introduction

I used random forest algorithm to make predictions for this challenge. First, I created some simple features according to the given data. I then used mice to impute missing data, specifically, the missing age data. In the second round of feature engineering, we used the full age data (and other things) to create some more features.

The final stage is feature selection and prediction. The resulting Kaggle score of this model is 0.80383 which put it to the top 18% of all submissions.

I thank Megan L. Risdal for her script that inspired me.

## 2 Loading Data and Libraries

```
In [4]: library(plyr)
        library(rpart)
        library(randomForest)
        library(ggplot2)
        library(Rcpp)
        library(mice)

In [5]: train <- read.csv("train.csv", na.string = "")
        test  <- read.csv("test.csv", na.string = "")
        test$Survived <- NA
        all_data <- rbind(train, test)
```

## 3 Feature Engineering

### 3.1 Title

```
In [6]: # Extract Title form name
        all_data$Title <- gsub('(.*, )|(\\.*)', '', all_data$Name)

In [7]: #Show title counts by sex
        print(table(all_data$Sex, all_data$Title))
```

	Capt	Col	Don	Dona	Dr	Jonkheer	Lady	Major	Master	Miss	Mlle	Mme	Mr	Mrs	
female			0	0	0	1	1	0	1	0	0	260	2	1	0 197
male			1	4	1	0	7	1	0	2	61	0	0	0	757 0

	Ms	Rev	Sir	the	Countess	
female	2	0	0			1
male	0	8	1			0

```

In [8]: all_data$Title <- mapvalues(all_data$Title, from = c("Mlle", "Col", "Major", "Jonkheer", "Don",
  "the Countess", "Ms", "Dona"),
  to = c("Miss", "Officer", "Officer", "Sir", "Sir", "Mrs", "Officer",
  "Lady", "Mrs", "Mrs"))
all_data$Title <- factor(all_data$Title)
print(unique(all_data$Title))

[1] Mr      Mrs      Miss     Master  Sir      Rev      Dr       Officer Lady
Levels: Dr Lady Master Miss Mr Mrs Officer Rev Sir

In [9]: # Separate the last names from names
all_data$SplitName <- strsplit(as.character(all_data$Name), ",")
all_data$LastName <- sapply(all_data$SplitName, "[", 1)

```

### 3.2 Family Size

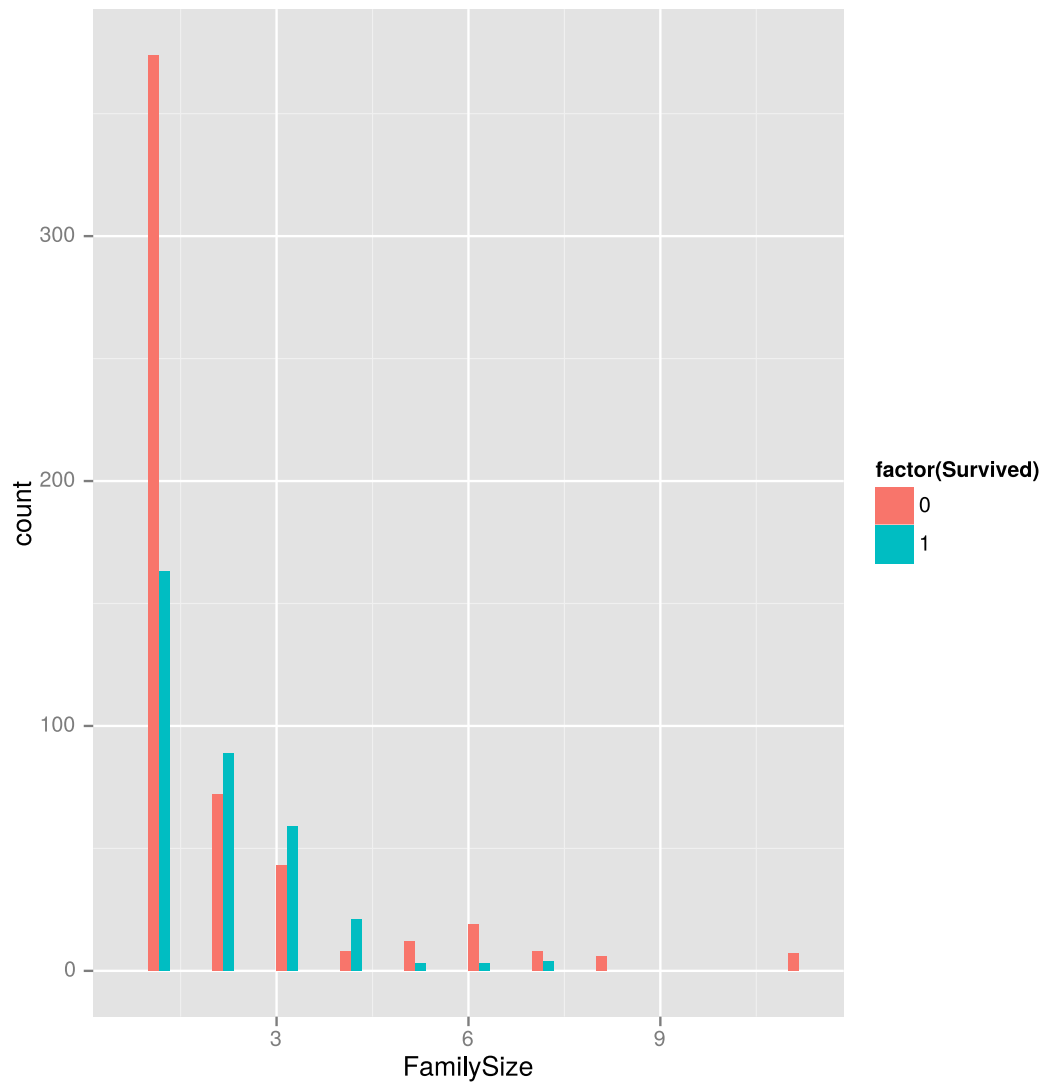
```

In [10]: all_data$FamilySize <- all_data$SibSp + all_data$Parch + 1
all_data$Family <- paste(all_data$LastName, all_data$FamilySize, sep = "_")

In [11]: # Plot family size v.s. survival
ggplot(all_data[1:891,], aes(x = FamilySize, fill = factor(Survived))) +
  geom_bar(position='dodge')

stat_bin: binwidth defaulted to range/30. Use 'binwidth = x' to adjust this.

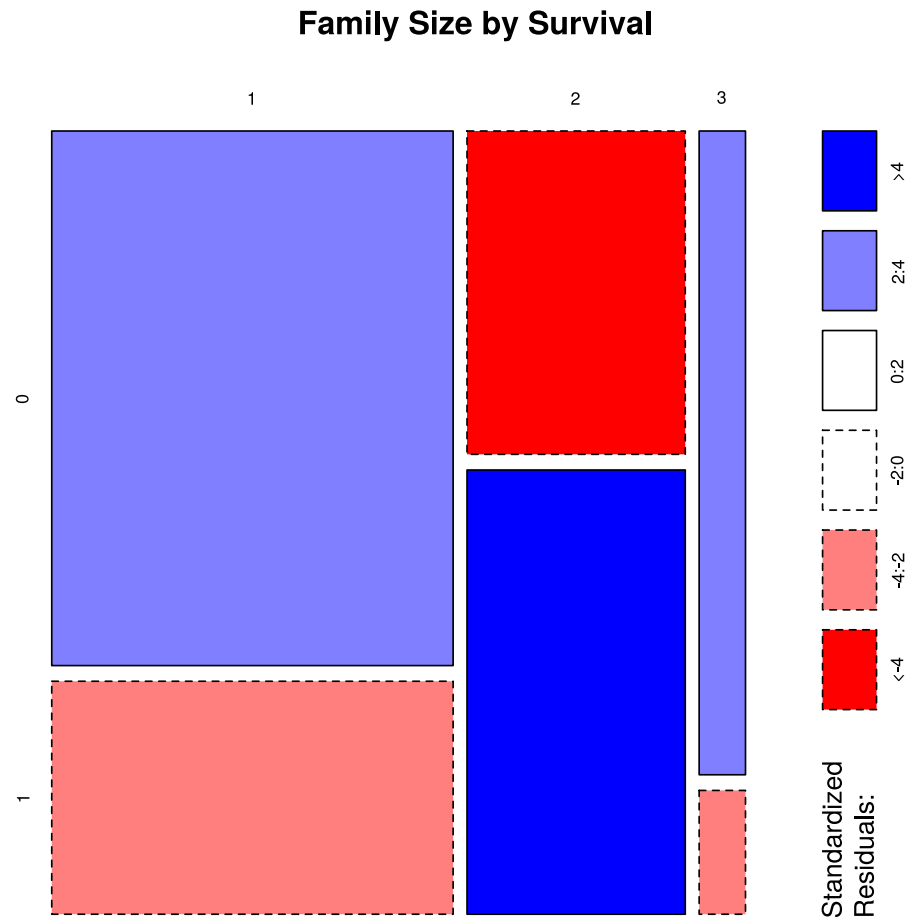
```



Because there are fewer large families and they perform similarly, it's useful to group some together.

```
In [12]: # Discretize family size
all_data$FsizeD[all_data$FamilySize == 1] <- 1
all_data$FsizeD[all_data$FamilySize < 5 & all_data$FamilySize > 1] <- 2
all_data$FsizeD[all_data$FamilySize > 4] <- 3

# Show family size by survival using a mosaic plot
mosaicplot(table(all_data$FsizeD, all_data$Survived), main='Family Size by Survival', shade=TRUE)
```



### 3.3 Missing Age and Cabin

Sometimes the missingness of data can be a clue too. We create a feature called “MissingAgeCabin” to indicate if a person is missing both Age and Cabin data.

```
In [13]: all_data$MissingAgeCabin[(is.na(all_data$Age)) & (is.na(all_data$Cabin))] <- 1
         all_data$MissingAgeCabin[(!is.na(all_data$Age)) | (!is.na(all_data$Cabin))] <- 0
```

### 3.4 Ticket Group Size

Notice some of these ticket numbers are the same. They might have bought the tickets at the same time. So they might be related or they might be friends. Create a feature called “TicketGroupSize” to indicate the size of group of people who share the same Ticket number.

```
In [14]: all_data$TicketGroupSize <- mapvalues(all_data$Ticket, from = as.vector(as.data.frame(table(all_data$Ticket))$Freq),
        to = as.vector(as.data.frame(table(all_data$Ticket))$Freq))
```

## 4 Fill in Missing Data

### 4.1 Embarked

See first whose Embarked data is missing.

```
In [15]: print(all_data[is.na(all_data$Embarked),])
```

PassengerId	Survived	Pclass	Name
62	62	1	1 Icard, Miss. Amelie
830	830	1	1 Stone, Mrs. George Nelson (Martha Evelyn)

	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Embarked	Title
62	female	38	0	0	113572	80	B28	<NA>	Miss
830	female	62	0	0	113572	80	B28	<NA>	Mrs

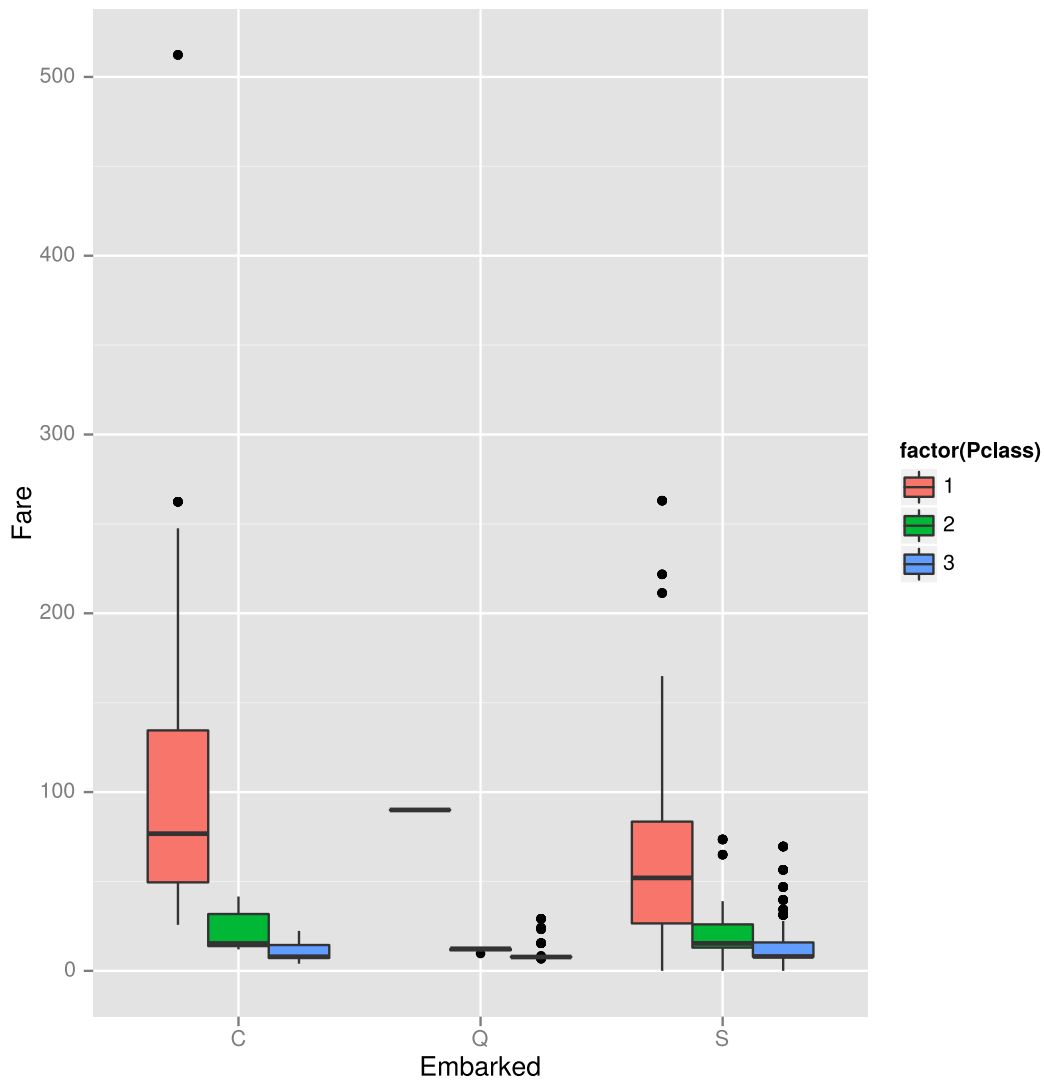
	SplitName	LastName	FamilySize	Family
62	Icard, Miss. Amelie	Icard	1	Icard.1
830	Stone, Mrs. George Nelson (Martha Evelyn)	Stone	1	Stone.1

	FsizeD	MissingAge	Cabin	TicketGroupSize
62	1		0	2
830	1		0	2

It looks like only passenger 62 and 830 has missing Embarked data. They are both female, and their ticket fare are both 80 and they also have the same Ticket number. So it's likely that they embarked at the same place.

```
In [16]: ggplot(all_data[(!is.na(all_data$Embarked))&(!is.na(all_data$Fare)),],  
             aes(x = Embarked, y = Fare, fill = factor(Pclass))) +  
             geom_boxplot()
```



From the plot, it's more likely that they departed from port "C" based on the fare they paid.

```
In [17]: # Fill the Embarked data with "C"
         all_data$Embarked[is.na(all_data$Embarked)] <- 'C'

In [18]: # Fill in the one missing Fare value
         all_data$Fare[1044] <- median(all_data[all_data$Pclass == '3' & all_data$Embarked == 'C', ]$Fare)

In [19]: print(all_data$Embarked[is.na(all_data$Embarked)])

factor(0)
Levels: C Q S
```

## 4.2 Age

There are quite a bit of missing age data.

```
In [20]: print(sum(is.na(all_data$Age)))
```

[1] 263

We give two ways of filling in the missing data. One using random forest, the other using mice. Mice performs better than random forest.

```
In [21]: # # Set a random seed
# set.seed(129)

# # Perform random forest to imputate Age
# predicted_age <- randomForest(Age ~ Pclass + Sex + SibSp + Parch + Fare + Embarked + Title +
#                               data = all_data[!is.na(all_data$Age),], ntree = 1000)
# all_data$Age[is.na(all_data$Age)] <- predict(predicted_age, all_data[is.na(all_data$Age),])

In [22]: # Use mice to imputate Age
# Make variables factors into factors
factor_vars <- c('PassengerId', 'Pclass', 'Sex', 'Embarked',
                 'Title', 'LastName', 'Family', 'FsizeD')

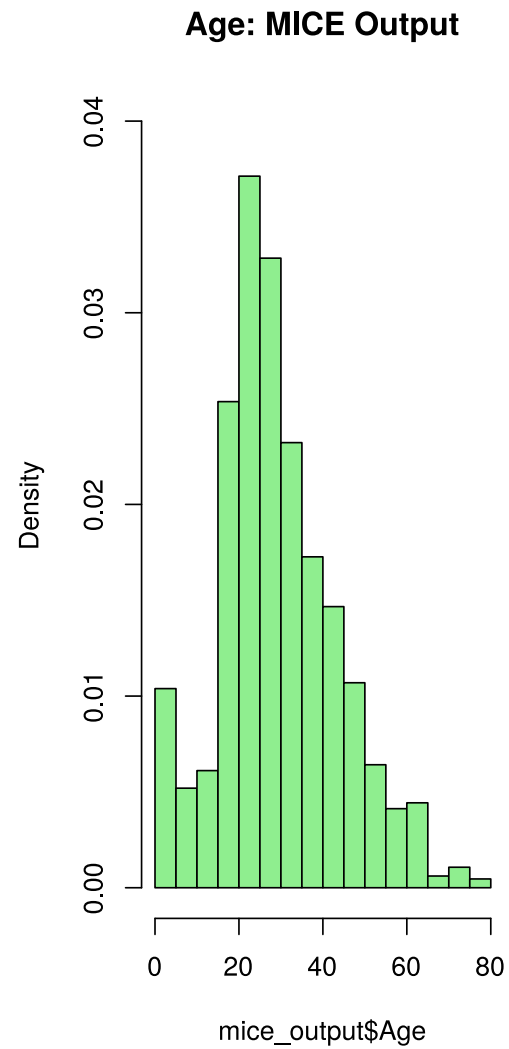
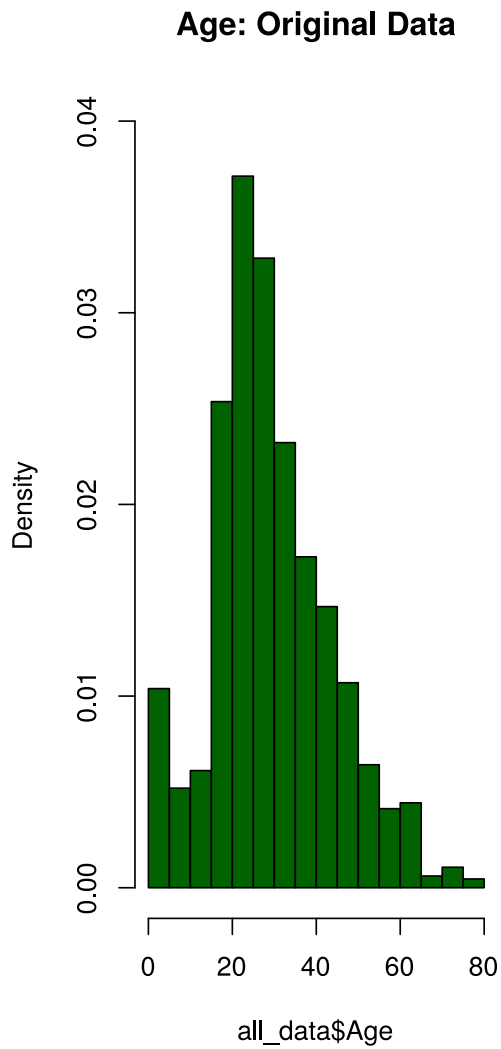
all_data[factor_vars] <- lapply(all_data[factor_vars], function(x) as.factor(x))

# Set a random seed
set.seed(129)
# Perform mice imputation, excluding certain less-than-useful variables:
mice_mod <- mice(all_data[, !names(all_data) %in%
                      c('PassengerId', 'Name', 'Ticket', 'Cabin', 'Family', 'LastName', 'Survived')],
                 method='rf')
# Save the complete output
mice_output <- complete(mice_mod)
# Replace Age variable from the mice model.
all_data$Age <- mice_output$Age

par(mfrow=c(1,2))
hist(all_data$Age, freq=F, main='Age: Original Data',
     col='darkgreen', ylim=c(0,0.04))
hist(mice_output$Age, freq=F, main='Age: MICE Output',
     col='lightgreen', ylim=c(0,0.04))

iter imp variable
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1 2 Age
1 3 Age
1 4 Age
1 5 Age
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2 2 Age
2 3 Age
2 4 Age
2 5 Age
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3 2 Age
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3 5 Age
4 1 Age
4 2 Age
```

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4	5	Age
5	1	Age
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5	3	Age
5	4	Age
5	5	Age



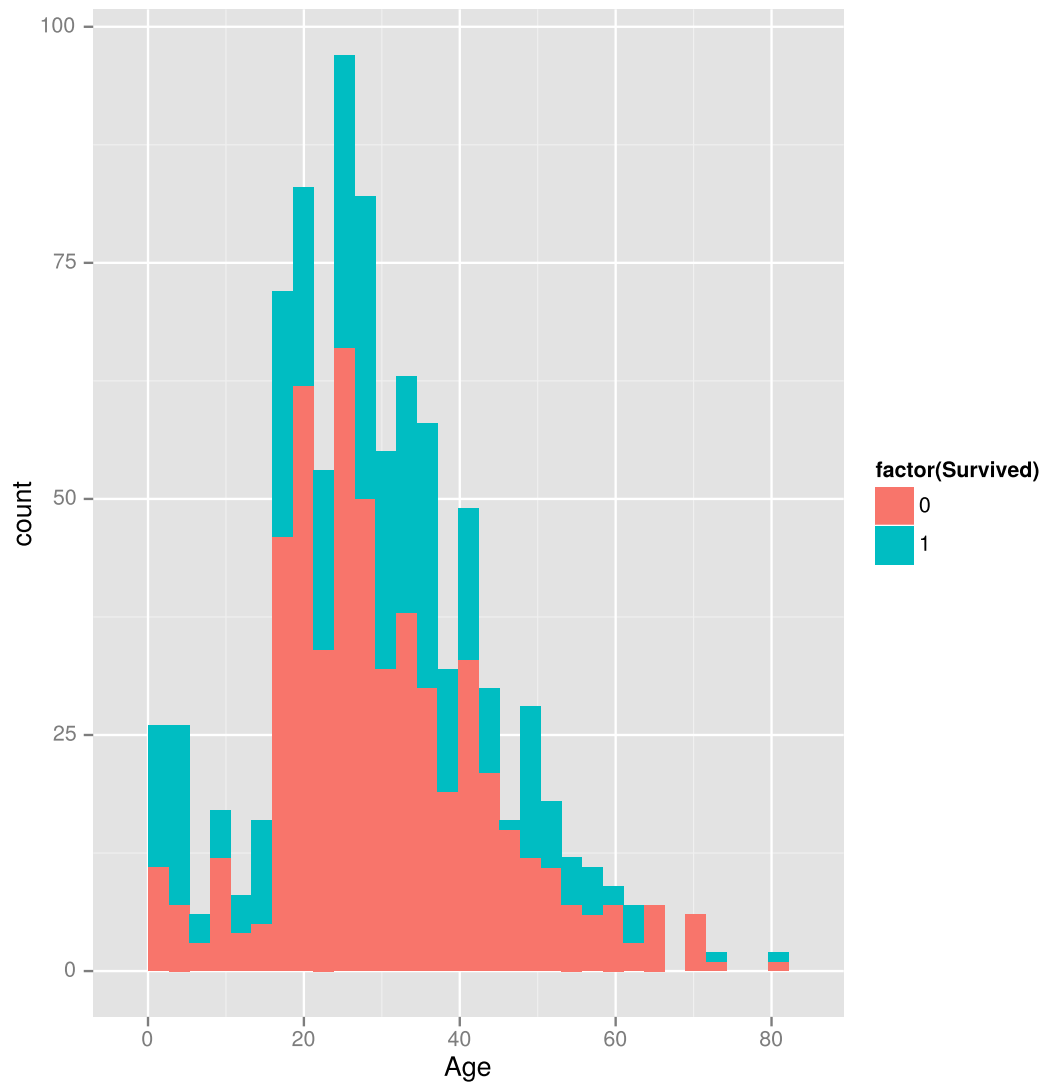
```
In [23]: # Show new number of missing Age values
sum(is.na(all_data$Age))
```

```
Out[23]:
0
```



```
In [24]: # We look at the relation between age and survival
ggplot(all_data[1:891,], aes(Age, fill = factor(Survived))) +
  geom_histogram()

stat_bin: binwidth defaulted to range/30. Use 'binwidth = x' to adjust this.
```



## 5 Age Related Feature Engineering

```
In [25]: # Create a Child feature
all_data$Child[all_data$Age < 10] <- "Child"
all_data$Child[all_data$Age >= 10]<- "Adult"
```

```
In [26]: # Create a Mother feature
all_data$Mother <- 'Not Mother'
all_data$Mother[all_data$Sex == 'female' & all_data$Parch > 0 & all_data$Age > 18 & all_data$T
```

```
In [27]: # Factor the features
all_data$Child <- factor(all_data$Child)
all_data$Mother <- factor(all_data$Mother)
all_data$FsizeD <- factor(all_data$FsizeD)
```

## 6 Model

```
In [28]: train_filled <- data.frame(all_data[1:891,],stringsAsFactors = TRUE)
test_filled <- data.frame(all_data[892:1309,],stringsAsFactors = TRUE)
```

```
In [29]: # See all features
print(colnames(train_filled))
```

```
[1] "PassengerId"      "Survived"          "Pclass"            "Name"
[5] "Sex"              "Age"               "SibSp"             "Parch"
[9] "Ticket"           "Fare"              "Cabin"             "Embarked"
[13] "Title"            "SplitName"         "LastName"          "FamilySize"
[17] "Family"           "FsizeD"            "MissingAgeCabin"   "TicketGroupSize"
[21] "Child"            "Mother"            "FsizeD"
```

```
In [30]: set.seed(754)
```

```
# Build the model (note: not all possible variables are used)
rf_full <- randomForest(as.factor(Survived) ~ Pclass + Sex + Age + SibSp + Parch +
                        Fare + Embarked + Title + Child + Mother + FsizeD +
                        TicketGroupSize + MissingAgeCabin,
                        data = train_filled, importance = TRUE, proximity=
                        ntree = 1000, nodesize = 100)
```

```
# Show model error
plot(rf_full, ylim=c(0,0.36))
legend('topright', colnames(rf_full$err.rate), col=1:3, fill=1:3)
```

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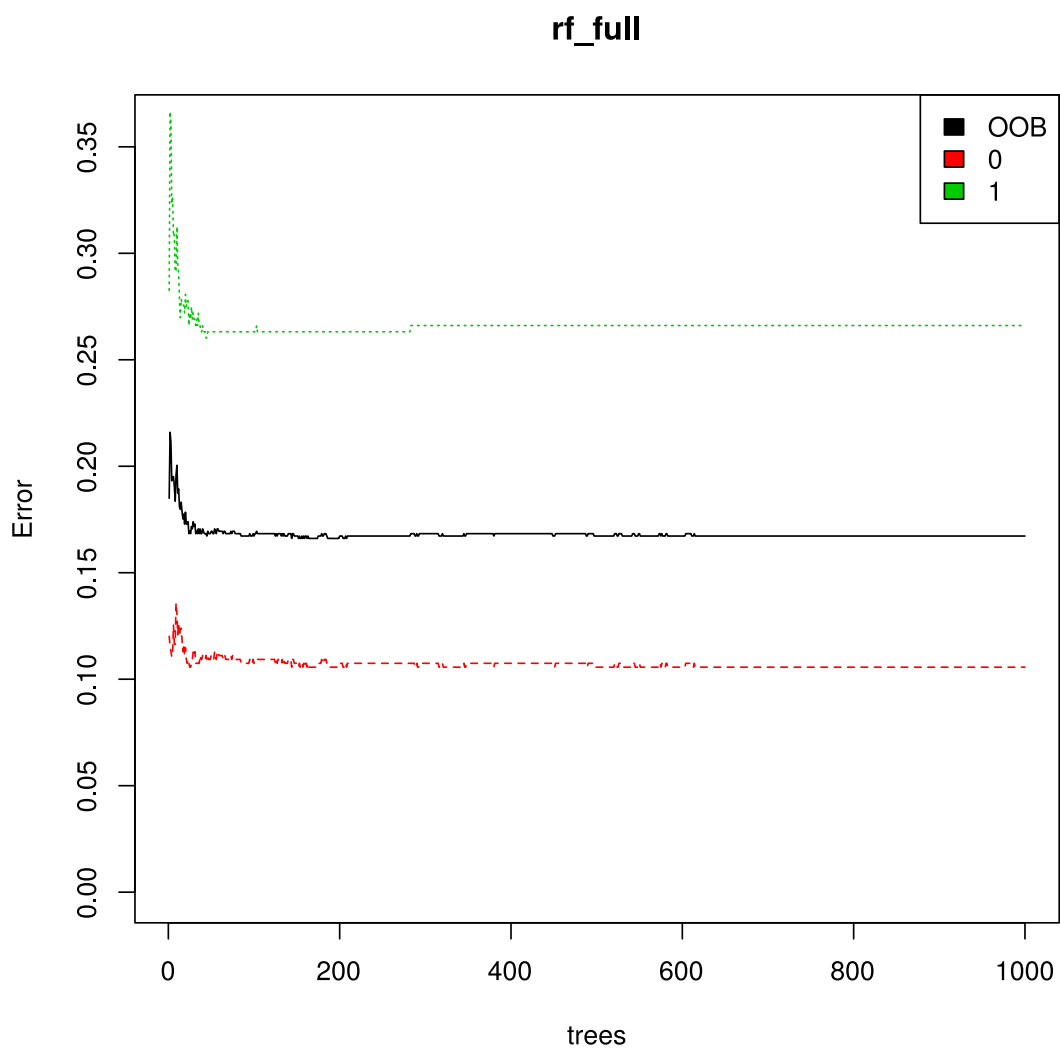
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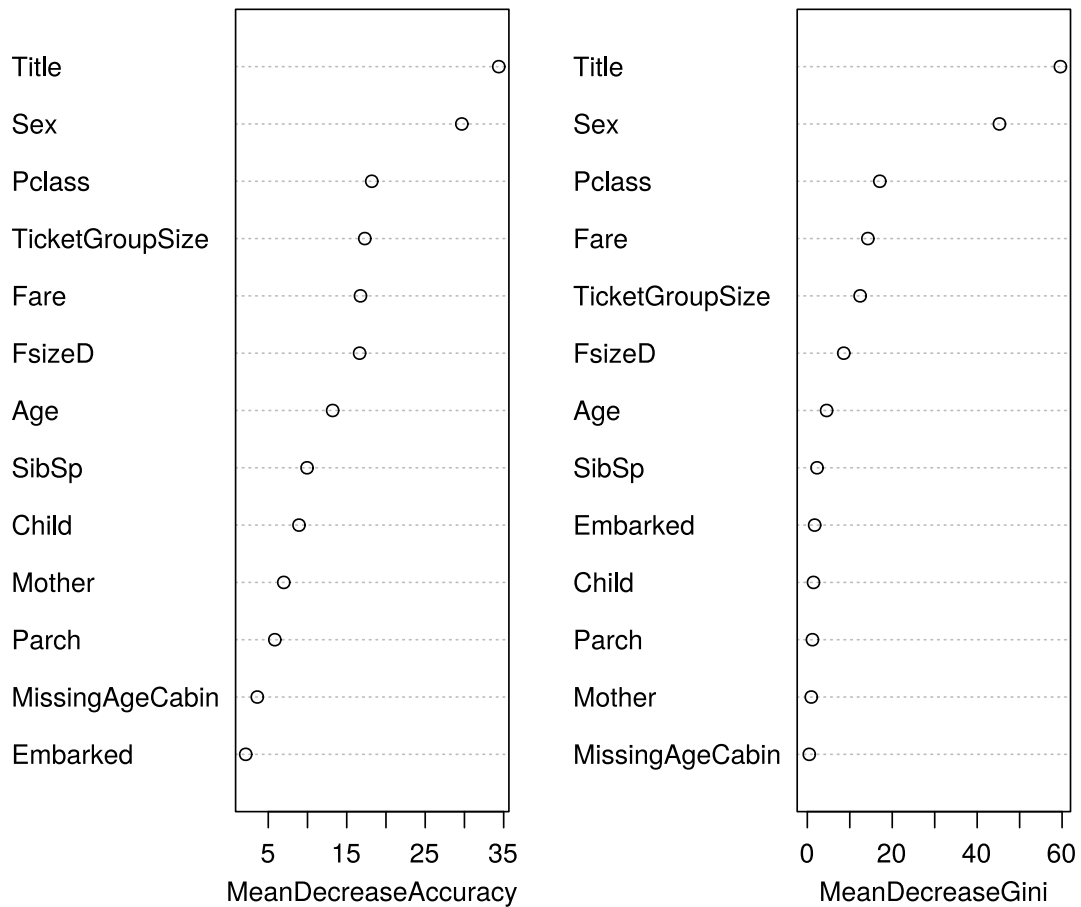
## 6.1 Feature Selection

```
In [31]: print(varImpPlot(rf_full))
```

	MeanDecreaseAccuracy	MeanDecreaseGini
Pclass	18.189164	17.0716328
Sex	29.664352	45.2490122

Age	13.204991	4.5439049
SibSp	9.945080	2.2885566
Parch	5.834147	1.2037244
Fare	16.749751	14.2592267
Embarked	2.126118	1.7259151
Title	34.376434	59.5971951
Child	8.918458	1.4526255
Mother	6.975009	0.9303821
FsizeD	16.640942	8.5832536
TicketGroupSize	17.301785	12.4425197
MissingAgeCabin	3.601815	0.4604249

rf\_full



Select the features Title, Sex, Pclass, TicketGroupSize, FsizeD, Fare, Child. This selection is made after a few rounds of trial and error together with some gussing based on common sense...

```
In [32]: set.seed(754)
```

```

# Build the model (note: not all possible variables are used)
my_forest <- randomForest(as.factor(Survived) ~ Title + Sex + Pclass + TicketGroupSize + Fsize,
                           data = train_filled, importance = TRUE, proximity=
                           ntree = 1000, nodesize = 100)

```

ntree	OOB	1	2
1:	18.50%	11.06%	29.71%
2:	20.29%	13.64%	30.18%
3:	19.68%	13.77%	28.84%
4:	18.74%	12.83%	28.22%
5:	17.99%	11.99%	27.72%
6:	19.09%	12.43%	29.87%
7:	18.19%	11.72%	28.79%
8:	18.20%	11.57%	28.92%
9:	18.63%	11.83%	29.64%
10:	18.78%	12.27%	29.29%
11:	19.41%	13.00%	29.71%
12:	19.37%	12.61%	30.21%
13:	18.99%	12.02%	30.21%
14:	18.65%	11.66%	29.91%
15:	18.86%	12.02%	29.82%
16:	18.97%	11.66%	30.70%
17:	18.41%	11.48%	29.53%
18:	18.63%	11.48%	30.12%
19:	18.18%	11.48%	28.95%
20:	17.96%	11.11%	28.95%
21:	18.18%	11.29%	29.24%
22:	17.73%	11.48%	27.78%
23:	18.29%	11.29%	29.53%
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## 7 Prediction

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In [33]: # Predict using the test set
         prediction <- predict(my_forest, test_filled)

         # Save the solution to a dataframe with two columns: PassengerId and Survived (prediction)
         solution <- data.frame(PassengerID = test$PassengerId, Survived = prediction)

         # Write the solution to file
         write.csv(solution, file = 'improved_R_Solution.csv', row.names = FALSE)

```