finalproj

12/13/2019

```r
library(dplyr) # data manipulation
```

```
##
## 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
```

```r
library(caTools) # splits
library(ggplot2) # plot graph
library(randomForest) # Random Forest
```

```
## randomForest 4.6-14

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

##
## Attaching package: 'randomForest'

## The following object is masked from 'package:ggplot2':
##
##     margin

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

```r
library(rpart)
library(rpart.plot)
library(caret)
```

```
## Loading required package: lattice
```

```r
library(lubridate)
```

```
##
## Attaching package: 'lubridate'

## The following object is masked from 'package:base':
##
##     date
```

```r
library(gbm)
```

```
## Loaded gbm 2.1.5
```

```r
OSR2 <- function(predictions, test, train) {
  SSE <- sum((test - predictions)^2)
  SST <- sum((test - mean(train))^2)
  r2 <- 1 - SSE/SST
```

```
  return(r2)
}
```

```
us <- read.csv("us_suicides_merged_no_na.csv")
```

```
suicide_us <- us %>%  select(year, sex, suicides_no, population, suicides.100k.pop, HDI.for.year, gdp_fo
```

```
suicide_us$year <- as.factor(suicide_us$year)
```

```
# split data for us
set.seed(377)
train.ids_us = sample(nrow(suicide_us), 0.70*nrow(suicide_us))
train_us <- suicide_us[train.ids_us,]
test_us <- suicide_us[-train.ids_us,]
```

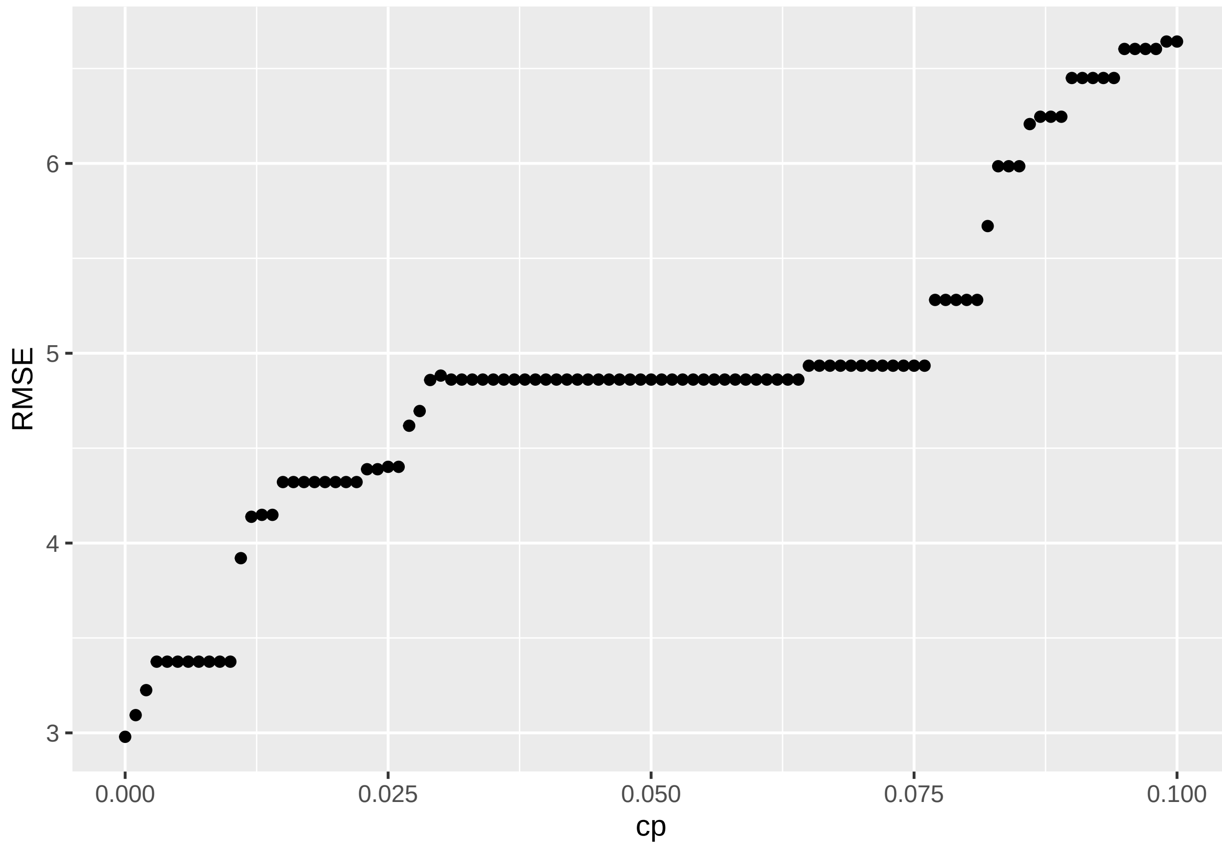
CART

```
set.seed(377)


us_train.cart = train(suicides.100k.pop ~ .,
                      data = train_us,
                      method = "rpart",
                      tuneGrid = data.frame(cp=seq(0, 0.1, 0.001)),
                      trControl = trainControl(method="cv", number=10),
                      metric = "RMSE")
us_train.cart$bestTune
```

```
##   cp
## 1  0
```

```
ggplot(us_train.cart$results, aes(x=cp, y=RMSE)) + geom_point()
```




```
us_train.cart$results
```

```
##       cp     RMSE  Rsquared      MAE   RMSESD RsquaredSD     MAESD
## 1  0.000 2.979329 0.9299221 1.199689 3.225845  0.1279826 0.7136592
## 2  0.001 3.093575 0.9277967 1.404896 3.194623  0.1285093 0.6913812
## 3  0.002 3.225177 0.9234075 1.554537 3.217963  0.1315820 0.7476110
## 4  0.003 3.375140 0.9194188 1.738446 3.157827  0.1314394 0.7601279
## 5  0.004 3.375140 0.9194188 1.738446 3.157827  0.1314394 0.7601279
## 6  0.005 3.375140 0.9194188 1.738446 3.157827  0.1314394 0.7601279
## 7  0.006 3.375140 0.9194188 1.738446 3.157827  0.1314394 0.7601279
## 8  0.007 3.375140 0.9194188 1.738446 3.157827  0.1314394 0.7601279
## 9  0.008 3.375140 0.9194188 1.738446 3.157827  0.1314394 0.7601279
## 10 0.009 3.375140 0.9194188 1.738446 3.157827  0.1314394 0.7601279
## 11 0.010 3.375140 0.9194188 1.738446 3.157827  0.1314394 0.7601279
## 12 0.011 3.920498 0.9041719 2.305750 2.903154  0.1267028 0.6481499
## 13 0.012 4.138473 0.8952126 2.487929 2.919139  0.1304562 0.7615112
## 14 0.013 4.148571 0.8954976 2.485649 2.928927  0.1289138 0.7723281
## 15 0.014 4.148571 0.8954976 2.485649 2.928927  0.1289138 0.7723281
## 16 0.015 4.321436 0.8799357 2.518585 3.284802  0.1667361 0.8338564
## 17 0.016 4.321436 0.8799357 2.518585 3.284802  0.1667361 0.8338564
## 18 0.017 4.321436 0.8799357 2.518585 3.284802  0.1667361 0.8338564
## 19 0.018 4.321436 0.8799357 2.518585 3.284802  0.1667361 0.8338564
## 20 0.019 4.321436 0.8799357 2.518585 3.284802  0.1667361 0.8338564
## 21 0.020 4.321436 0.8799357 2.518585 3.284802  0.1667361 0.8338564
## 22 0.021 4.321436 0.8799357 2.518585 3.284802  0.1667361 0.8338564
## 23 0.022 4.321436 0.8799357 2.518585 3.284802  0.1667361 0.8338564
## 24 0.023 4.388922 0.8755937 2.607405 3.422550  0.1734971 1.0382248
```

```
## 25  0.024 4.388922 0.8755937 2.607405 3.422550  0.1734971 1.0382248
## 26  0.025 4.401650 0.8750325 2.635935 3.449401  0.1748987 1.0841685
## 27  0.026 4.401650 0.8750325 2.635935 3.449401  0.1748987 1.0841685
## 28  0.027 4.618113 0.8704746 2.761382 3.361284  0.1724605 1.0469658
## 29  0.028 4.695637 0.8680869 2.780571 3.338454  0.1714471 1.0421989
## 30  0.029 4.859037 0.8660092 2.899967 3.245508  0.1704052 0.9986216
## 31  0.030 4.882301 0.8666749 2.910465 3.225638  0.1708483 0.9861274
## 32  0.031 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 33  0.032 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 34  0.033 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 35  0.034 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 36  0.035 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 37  0.036 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 38  0.037 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 39  0.038 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 40  0.039 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 41  0.040 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 42  0.041 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 43  0.042 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 44  0.043 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 45  0.044 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 46  0.045 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 47  0.046 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 48  0.047 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 49  0.048 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 50  0.049 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 51  0.050 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 52  0.051 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 53  0.052 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 54  0.053 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 55  0.054 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 56  0.055 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 57  0.056 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 58  0.057 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 59  0.058 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 60  0.059 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 61  0.060 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 62  0.061 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 63  0.062 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 64  0.063 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 65  0.064 4.861378 0.8679781 2.899746 3.240825  0.1715778 0.9970946
## 66  0.065 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 67  0.066 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 68  0.067 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 69  0.068 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 70  0.069 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 71  0.070 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 72  0.071 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 73  0.072 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 74  0.073 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 75  0.074 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 76  0.075 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 77  0.076 4.934361 0.8606146 3.059289 3.398389  0.1905633 1.3213671
## 78  0.077 5.280960 0.8462010 3.362222 3.443466  0.1883127 1.5240413
```

```
## 79  0.078 5.280960 0.8462010 3.362222 3.443466  0.1883127 1.5240413
## 80  0.079 5.280960 0.8462010 3.362222 3.443466  0.1883127 1.5240413
## 81  0.080 5.280960 0.8462010 3.362222 3.443466  0.1883127 1.5240413
## 82  0.081 5.280960 0.8462010 3.362222 3.443466  0.1883127 1.5240413
## 83  0.082 5.670020 0.8203833 3.656730 3.311591  0.1868571 1.4931868
## 84  0.083 5.985219 0.8024132 3.897906 3.138200  0.1804592 1.3748995
## 85  0.084 5.985219 0.8024132 3.897906 3.138200  0.1804592 1.3748995
## 86  0.085 5.985219 0.8024132 3.897906 3.138200  0.1804592 1.3748995
## 87  0.086 6.207410 0.7891493 4.068535 2.992776  0.1745661 1.2807708
## 88  0.087 6.245957 0.7861506 4.156334 3.060970  0.1780620 1.3742501
## 89  0.088 6.245957 0.7861506 4.156334 3.060970  0.1780620 1.3742501
## 90  0.089 6.245957 0.7861506 4.156334 3.060970  0.1780620 1.3742501
## 91  0.090 6.450051 0.7771554 4.303759 2.948063  0.1716057 1.2971819
## 92  0.091 6.450051 0.7771554 4.303759 2.948063  0.1716057 1.2971819
## 93  0.092 6.450051 0.7771554 4.303759 2.948063  0.1716057 1.2971819
## 94  0.093 6.450051 0.7771554 4.303759 2.948063  0.1716057 1.2971819
## 95  0.094 6.450051 0.7771554 4.303759 2.948063  0.1716057 1.2971819
## 96  0.095 6.603046 0.7687192 4.419024 2.789900  0.1629593 1.1658689
## 97  0.096 6.603046 0.7687192 4.419024 2.789900  0.1629593 1.1658689
## 98  0.097 6.603046 0.7687192 4.419024 2.789900  0.1629593 1.1658689
## 99  0.098 6.603046 0.7687192 4.419024 2.789900  0.1629593 1.1658689
## 100 0.099 6.642118 0.7712096 4.477140 2.754341  0.1657459 1.0781541
## 101 0.100 6.642118 0.7712096 4.477140 2.754341  0.1657459 1.0781541
```

```r
mod.us_cart <- us_train.cart$finalModel
```

```r
us_test.cart = as.data.frame(model.matrix(suicides.100k.pop ~ . + 0, data=test_us))

predcart_us = predict(mod.us_cart, newdata=us_test.cart)
#predcart_us$results
cart.tab.us <- table(test_us$suicides.100k.pop, predcart_us)
cart.tab.us
```

```
##       predcart_us
##         0.35125 0.608571428571429 1.09722222222222 3.26 3.75555555555556
##   0.28        1                 0                0    0                0
##   0.31        1                 0                0    0                0
##   0.37        1                 0                0    0                0
##   0.39        1                 0                0    0                0
##   0.41        1                 0                0    0                0
##   0.42        1                 0                0    0                0
##   0.43        0                 1                0    0                0
##   0.44        1                 0                0    0                0
##   0.45        0                 1                0    0                0
##   0.74        0                 1                0    0                0
##   0.78        0                 1                0    0                0
##   0.83        0                 0                1    0                0
##   0.88        0                 0                1    0                0
##   0.92        0                 0                1    0                0
##   1.02        0                 0                2    0                0
##   1.14        0                 0                2    0                0
##   1.24        0                 0                1    0                0
##   1.3         0                 0                1    0                0
##   1.33        0                 0                1    0                0
##   3.03        0                 0                0    1                0
```

```
##   3.12        0                 0                0    0                0
##   3.32        0                 0                0    0                0
##   3.61        0                 0                0    0                1
##   3.72        0                 0                0    0                0
##   3.77        0                 0                0    0                1
##   3.85        0                 0                0    0                1
##   3.88        0                 0                0    0                0
##   4           0                 0                0    0                0
##   4.08        0                 0                0    0                0
##   4.23        0                 0                0    0                0
##   4.32        0                 0                0    0                0
##   4.36        0                 0                0    0                0
##   4.59        0                 0                0    0                0
##   4.73        0                 0                0    0                0
##   4.77        0                 0                0    0                0
##   4.81        0                 0                0    0                0
##   4.95        0                 0                0    0                0
##   5.06        0                 0                0    0                0
##   5.07        0                 0                0    0                0
##   5.17        0                 0                0    0                0
##   5.38        0                 0                0    0                0
##   5.47        0                 0                0    0                0
##   5.61        0                 0                0    0                0
##   5.77        0                 0                0    0                0
##   6.02        0                 0                0    0                0
##   6.17        0                 0                0    0                0
##   6.21        0                 0                0    0                0
##   6.29        0                 0                0    0                0
##   6.4         0                 0                0    0                0
##   6.76        0                 0                0    0                0
##   6.8         0                 0                0    0                0
##   6.91        0                 0                0    0                0
##   7.06        0                 0                0    0                0
##   7.11        0                 0                0    0                0
##   7.3         0                 0                0    0                0
##   7.38        0                 0                0    0                0
##   7.48        0                 0                0    0                0
##   7.83        0                 0                0    0                0
##   7.9         0                 0                0    0                0
##   8.99        0                 0                0    0                0
##   16.09       0                 0                0    0                0
##   16.15       0                 0                0    0                0
##   16.16       0                 0                0    0                0
##   16.64       0                 0                0    0                0
##   17.2        0                 0                0    0                0
##   17.5        0                 0                0    0                0
##   18.01       0                 0                0    0                0
##   19.57       0                 0                0    0                0
##   20          0                 0                0    0                0
##   20.98       0                 0                0    0                0
##   21.26       0                 0                0    0                0
##   21.89       0                 0                0    0                0
##   21.92       0                 0                0    0                0
##   22.24       0                 0                0    0                0
```

```
##   22.25       0                 0                0    0                0
##   22.41       0                 0                0    0                0
##   22.61       0                 0                0    0                0
##   22.62       0                 0                0    0                0
##   23.3        0                 0                0    0                0
##   23.45       0                 0                0    0                0
##   23.57       0                 0                0    0                0
##   23.88       0                 0                0    0                0
##   24          0                 0                0    0                0
##   24.01       0                 0                0    0                0
##   24.03       0                 0                0    0                0
##   24.12       0                 0                0    0                0
##   24.62       0                 0                0    0                0
##   24.76       0                 0                0    0                0
##   24.78       0                 0                0    0                0
##   24.86       0                 0                0    0                0
##   25.02       0                 0                0    0                0
##   25.06       0                 0                0    0                0
##   25.48       0                 0                0    0                0
##   25.52       0                 0                0    0                0
##   25.61       0                 0                0    0                0
##   25.62       0                 0                0    0                0
##   26.34       0                 0                0    0                0
##   26.41       0                 0                0    0                0
##   26.52       0                 0                0    0                0
##   26.71       0                 0                0    0                0
##   27.05       0                 0                0    0                0
##   27.93       0                 0                0    0                0
##   28.11       0                 0                0    0                0
##   36.53       0                 0                0    0                0
##   37.11       0                 0                0    0                0
##   45.15       0                 0                0    0                0
##   52.33       0                 0                0    0                0
##   57.85       0                 0                0    0                0
##        predcart_us
##         3.93727272727273 4.59416666666667 5.132 5.78153846153846 6.07375
##   0.28                 0                0     0                0       0
##   0.31                 0                0     0                0       0
##   0.37                 0                0     0                0       0
##   0.39                 0                0     0                0       0
##   0.41                 0                0     0                0       0
##   0.42                 0                0     0                0       0
##   0.43                 0                0     0                0       0
##   0.44                 0                0     0                0       0
##   0.45                 0                0     0                0       0
##   0.74                 0                0     0                0       0
##   0.78                 0                0     0                0       0
##   0.83                 0                0     0                0       0
##   0.88                 0                0     0                0       0
##   0.92                 0                0     0                0       0
##   1.02                 0                0     0                0       0
##   1.14                 0                0     0                0       0
##   1.24                 0                0     0                0       0
##   1.3                  0                0     0                0       0
```

```
##   1.33              0                0     0                0      0
##   3.03              0                0     0                0      0
##   3.12              1                0     0                0      0
##   3.32              1                0     0                0      0
##   3.61              0                0     0                0      0
##   3.72              1                0     0                0      0
##   3.77              0                0     0                0      0
##   3.85              0                0     0                0      0
##   3.88              0                1     0                0      0
##   4                 0                1     0                0      0
##   4.08              1                0     0                0      0
##   4.23              1                0     0                0      0
##   4.32              0                1     0                0      0
##   4.36              0                1     0                0      0
##   4.59              1                0     0                0      0
##   4.73              0                1     0                0      0
##   4.77              0                1     1                0      0
##   4.81              0                0     0                0      1
##   4.95              0                0     1                0      0
##   5.06              0                0     1                0      0
##   5.07              0                0     0                0      1
##   5.17              1                0     0                0      0
##   5.38              0                0     2                0      0
##   5.47              0                0     0                0      1
##   5.61              0                0     0                1      0
##   5.77              0                0     0                0      0
##   6.02              0                0     0                0      0
##   6.17              0                0     0                0      1
##   6.21              0                0     0                1      0
##   6.29              0                0     0                1      0
##   6.4               0                0     0                0      1
##   6.76              0                0     0                0      0
##   6.8               0                0     0                0      0
##   6.91              0                0     0                0      0
##   7.06              0                0     0                0      0
##   7.11              0                0     0                0      0
##   7.3               0                0     0                0      0
##   7.38              0                0     0                0      0
##   7.48              0                0     0                0      0
##   7.83              0                0     0                0      0
##   7.9               0                0     0                0      0
##   8.99              0                0     0                0      0
##   16.09             0                0     0                0      0
##   16.15             0                0     0                0      0
##   16.16             0                0     0                0      0
##   16.64             0                0     0                0      0
##   17.2              0                0     0                0      0
##   17.5              0                0     0                0      0
##   18.01             0                0     0                0      0
##   19.57             0                0     0                0      0
##   20                0                0     0                0      0
##   20.98             0                0     0                0      0
##   21.26             0                0     0                0      0
##   21.89             0                0     0                0      0
```

```
##   21.92                0                0     0                0       0
##   22.24                0                0     0                0       0
##   22.25                0                0     0                0       0
##   22.41                0                0     0                0       0
##   22.61                0                0     0                0       0
##   22.62                0                0     0                0       0
##   23.3                 0                0     0                0       0
##   23.45                0                0     0                0       0
##   23.57                0                0     0                0       0
##   23.88                0                0     0                0       0
##   24                   0                0     0                0       0
##   24.01                0                0     0                0       0
##   24.03                0                0     0                0       0
##   24.12                0                0     0                0       0
##   24.62                0                0     0                0       0
##   24.76                0                0     0                0       0
##   24.78                0                0     0                0       0
##   24.86                0                0     0                0       0
##   25.02                0                0     0                0       0
##   25.06                0                0     0                0       0
##   25.48                0                0     0                0       0
##   25.52                0                0     0                0       0
##   25.61                0                0     0                0       0
##   25.62                0                0     0                0       0
##   26.34                0                0     0                0       0
##   26.41                0                0     0                0       0
##   26.52                0                0     0                0       0
##   26.71                0                0     0                0       0
##   27.05                0                0     0                0       0
##   27.93                0                0     0                0       0
##   28.11                0                0     0                0       0
##   36.53                0                0     0                0       0
##   37.11                0                0     0                0       0
##   45.15                0                0     0                0       0
##   52.33                0                0     0                0       0
##   57.85                0                0     0                0       0
##        predcart_us
##         6.88636363636364 7.1625 8.865 16.9827272727273 21.1638888888889
##   0.28                 0      0     0                0                0
##   0.31                 0      0     0                0                0
##   0.37                 0      0     0                0                0
##   0.39                 0      0     0                0                0
##   0.41                 0      0     0                0                0
##   0.42                 0      0     0                0                0
##   0.43                 0      0     0                0                0
##   0.44                 0      0     0                0                0
##   0.45                 0      0     0                0                0
##   0.74                 0      0     0                0                0
##   0.78                 0      0     0                0                0
##   0.83                 0      0     0                0                0
##   0.88                 0      0     0                0                0
##   0.92                 0      0     0                0                0
##   1.02                 0      0     0                0                0
##   1.14                 0      0     0                0                0
```

```
##    1.24                      0      0     0                0                0
##    1.3                       0      0     0                0                0
##    1.33                      0      0     0                0                0
##    3.03                      0      0     0                0                0
##    3.12                      0      0     0                0                0
##    3.32                      0      0     0                0                0
##    3.61                      0      0     0                0                0
##    3.72                      0      0     0                0                0
##    3.77                      0      0     0                0                0
##    3.85                      0      0     0                0                0
##    3.88                      0      0     0                0                0
##    4                         0      0     0                0                0
##    4.08                      0      0     0                0                0
##    4.23                      0      0     0                0                0
##    4.32                      0      0     0                0                0
##    4.36                      0      0     0                0                0
##    4.59                      0      0     0                0                0
##    4.73                      0      0     0                0                0
##    4.77                      0      0     0                0                0
##    4.81                      0      0     0                0                0
##    4.95                      0      0     0                0                0
##    5.06                      0      0     0                0                0
##    5.07                      0      0     0                0                0
##    5.17                      0      0     0                0                0
##    5.38                      0      0     0                0                0
##    5.47                      0      0     0                0                0
##    5.61                      0      0     0                0                0
##    5.77                      1      0     0                0                0
##    6.02                      1      0     0                0                0
##    6.17                      0      0     0                0                0
##    6.21                      0      0     0                0                0
##    6.29                      0      0     0                0                0
##    6.4                       0      0     0                0                0
##    6.76                      0      1     0                0                0
##    6.8                       0      1     0                0                0
##    6.91                      1      0     0                0                0
##    7.06                      1      0     0                0                0
##    7.11                      0      1     0                0                0
##    7.3                       0      1     0                0                0
##    7.38                      0      1     0                0                0
##    7.48                      0      1     0                0                0
##    7.83                      0      1     0                0                0
##    7.9                       1      0     0                0                0
##    8.99                      0      0     1                0                0
##    16.09                     0      0     0                1                0
##    16.15                     0      0     0                1                0
##    16.16                     0      0     0                1                0
##    16.64                     0      0     0                1                0
##    17.2                      0      0     0                1                0
##    17.5                      0      0     0                1                0
##    18.01                     0      0     0                0                1
##    19.57                     0      0     0                1                0
##    20                        0      0     0                1                0
##    20.98                     0      0     0                0                1
```

```
##   21.26                   0      0     0                0               1
##   21.89                   0      0     0                0               1
##   21.92                   0      0     0                0               1
##   22.24                   0      0     0                0               1
##   22.25                   0      0     0                0               0
##   22.41                   0      0     0                0               0
##   22.61                   0      0     0                0               0
##   22.62                   0      0     0                0               0
##   23.3                    0      0     0                0               0
##   23.45                   0      0     0                0               1
##   23.57                   0      0     0                0               0
##   23.88                   0      0     0                0               0
##   24                      0      0     0                0               0
##   24.01                   0      0     0                0               0
##   24.03                   0      0     0                0               0
##   24.12                   0      0     0                0               0
##   24.62                   0      0     0                0               0
##   24.76                   0      0     0                0               0
##   24.78                   0      0     0                0               0
##   24.86                   0      0     0                0               0
##   25.02                   0      0     0                0               0
##   25.06                   0      0     0                0               0
##   25.48                   0      0     0                0               0
##   25.52                   0      0     0                0               0
##   25.61                   0      0     0                0               0
##   25.62                   0      0     0                0               0
##   26.34                   0      0     0                0               0
##   26.41                   0      0     0                0               0
##   26.52                   0      0     0                0               0
##   26.71                   0      0     0                0               0
##   27.05                   0      0     0                0               0
##   27.93                   0      0     0                0               0
##   28.11                   0      0     0                0               0
##   36.53                   0      0     0                0               0
##   37.11                   0      0     0                0               0
##   45.15                   0      0     0                0               0
##   52.33                   0      0     0                0               0
##   57.85                   0      0     0                0               0
##        predcart_us
##         23.0911764705882 24.0785714285714 24.47 26.1814285714286
##   0.28                 0                0     0                0
##   0.31                 0                0     0                0
##   0.37                 0                0     0                0
##   0.39                 0                0     0                0
##   0.41                 0                0     0                0
##   0.42                 0                0     0                0
##   0.43                 0                0     0                0
##   0.44                 0                0     0                0
##   0.45                 0                0     0                0
##   0.74                 0                0     0                0
##   0.78                 0                0     0                0
##   0.83                 0                0     0                0
##   0.88                 0                0     0                0
##   0.92                 0                0     0                0
```

```
##    1.02                    0                 0     0                 0
##    1.14                    0                 0     0                 0
##    1.24                    0                 0     0                 0
##    1.3                     0                 0     0                 0
##    1.33                    0                 0     0                 0
##    3.03                    0                 0     0                 0
##    3.12                    0                 0     0                 0
##    3.32                    0                 0     0                 0
##    3.61                    0                 0     0                 0
##    3.72                    0                 0     0                 0
##    3.77                    0                 0     0                 0
##    3.85                    0                 0     0                 0
##    3.88                    0                 0     0                 0
##    4                       0                 0     0                 0
##    4.08                    0                 0     0                 0
##    4.23                    0                 0     0                 0
##    4.32                    0                 0     0                 0
##    4.36                    0                 0     0                 0
##    4.59                    0                 0     0                 0
##    4.73                    0                 0     0                 0
##    4.77                    0                 0     0                 0
##    4.81                    0                 0     0                 0
##    4.95                    0                 0     0                 0
##    5.06                    0                 0     0                 0
##    5.07                    0                 0     0                 0
##    5.17                    0                 0     0                 0
##    5.38                    0                 0     0                 0
##    5.47                    0                 0     0                 0
##    5.61                    0                 0     0                 0
##    5.77                    0                 0     0                 0
##    6.02                    0                 0     0                 0
##    6.17                    0                 0     0                 0
##    6.21                    0                 0     0                 0
##    6.29                    0                 0     0                 0
##    6.4                     0                 0     0                 0
##    6.76                    0                 0     0                 0
##    6.8                     0                 0     0                 0
##    6.91                    0                 0     0                 0
##    7.06                    0                 0     0                 0
##    7.11                    0                 0     0                 0
##    7.3                     0                 0     0                 0
##    7.38                    0                 0     0                 0
##    7.48                    0                 0     0                 0
##    7.83                    0                 0     0                 0
##    7.9                     0                 0     0                 0
##    8.99                    0                 0     0                 0
##    16.09                   0                 0     0                 0
##    16.15                   0                 0     0                 0
##    16.16                   0                 0     0                 0
##    16.64                   0                 0     0                 0
##    17.2                    0                 0     0                 0
##    17.5                    0                 0     0                 0
##    18.01                   0                 0     0                 0
##    19.57                   0                 0     0                 0
```

```
##   20                  0                0     0                0
##   20.98               0                0     0                0
##   21.26               0                0     0                0
##   21.89               0                0     0                0
##   21.92               0                0     0                0
##   22.24               0                0     0                0
##   22.25               1                0     0                0
##   22.41               1                0     0                0
##   22.61               1                0     0                0
##   22.62               0                1     0                0
##   23.3                1                0     0                0
##   23.45               0                0     0                0
##   23.57               0                1     0                0
##   23.88               0                1     0                0
##   24                  0                0     0                1
##   24.01               1                0     0                0
##   24.03               0                0     1                0
##   24.12               0                1     0                0
##   24.62               0                0     0                0
##   24.76               0                0     1                0
##   24.78               0                0     1                0
##   24.86               0                0     0                1
##   25.02               0                0     1                0
##   25.06               0                0     0                0
##   25.48               0                0     1                0
##   25.52               0                0     0                1
##   25.61               0                0     1                0
##   25.62               0                0     1                0
##   26.34               0                0     0                1
##   26.41               0                0     0                0
##   26.52               0                0     0                1
##   26.71               0                0     0                0
##   27.05               0                0     0                1
##   27.93               0                0     0                1
##   28.11               0                0     0                1
##   36.53               0                0     0                0
##   37.11               0                0     0                0
##   45.15               0                0     0                0
##   52.33               0                0     0                0
##   57.85               0                0     0                0
##        predcart_us
##         29.0328571428571 38.67125 53.46
##   0.28                0        0     0
##   0.31                0        0     0
##   0.37                0        0     0
##   0.39                0        0     0
##   0.41                0        0     0
##   0.42                0        0     0
##   0.43                0        0     0
##   0.44                0        0     0
##   0.45                0        0     0
##   0.74                0        0     0
##   0.78                0        0     0
##   0.83                0        0     0
```

```
##   0.88                   0         0     0
##   0.92                   0         0     0
##   1.02                   0         0     0
##   1.14                   0         0     0
##   1.24                   0         0     0
##   1.3                    0         0     0
##   1.33                   0         0     0
##   3.03                   0         0     0
##   3.12                   0         0     0
##   3.32                   0         0     0
##   3.61                   0         0     0
##   3.72                   0         0     0
##   3.77                   0         0     0
##   3.85                   0         0     0
##   3.88                   0         0     0
##   4                      0         0     0
##   4.08                   0         0     0
##   4.23                   0         0     0
##   4.32                   0         0     0
##   4.36                   0         0     0
##   4.59                   0         0     0
##   4.73                   0         0     0
##   4.77                   0         0     0
##   4.81                   0         0     0
##   4.95                   0         0     0
##   5.06                   0         0     0
##   5.07                   0         0     0
##   5.17                   0         0     0
##   5.38                   0         0     0
##   5.47                   0         0     0
##   5.61                   0         0     0
##   5.77                   0         0     0
##   6.02                   0         0     0
##   6.17                   0         0     0
##   6.21                   0         0     0
##   6.29                   0         0     0
##   6.4                    0         0     0
##   6.76                   0         0     0
##   6.8                    0         0     0
##   6.91                   0         0     0
##   7.06                   0         0     0
##   7.11                   0         0     0
##   7.3                    0         0     0
##   7.38                   0         0     0
##   7.48                   0         0     0
##   7.83                   0         0     0
##   7.9                    0         0     0
##   8.99                   0         0     0
##   16.09                  0         0     0
##   16.15                  0         0     0
##   16.16                  0         0     0
##   16.64                  0         0     0
##   17.2                   0         0     0
##   17.5                   0         0     0
```

```
##   18.01                  0         0     0
##   19.57                  0         0     0
##   20                     0         0     0
##   20.98                  0         0     0
##   21.26                  0         0     0
##   21.89                  0         0     0
##   21.92                  0         0     0
##   22.24                  0         0     0
##   22.25                  0         0     0
##   22.41                  0         0     0
##   22.61                  0         0     0
##   22.62                  0         0     0
##   23.3                   0         0     0
##   23.45                  0         0     0
##   23.57                  0         0     0
##   23.88                  0         0     0
##   24                     0         0     0
##   24.01                  0         0     0
##   24.03                  0         0     0
##   24.12                  0         0     0
##   24.62                  1         0     0
##   24.76                  0         0     0
##   24.78                  0         0     0
##   24.86                  0         0     0
##   25.02                  0         0     0
##   25.06                  1         0     0
##   25.48                  0         0     0
##   25.52                  0         0     0
##   25.61                  0         0     0
##   25.62                  0         0     0
##   26.34                  0         0     0
##   26.41                  1         0     0
##   26.52                  0         0     0
##   26.71                  1         0     0
##   27.05                  0         0     0
##   27.93                  0         0     0
##   28.11                  0         0     0
##   36.53                  0         1     0
##   37.11                  0         1     0
##   45.15                  0         1     0
##   52.33                  0         0     1
##   57.85                  0         0     1
```

```r
print("CART OSR2:")
```

```
## [1] "CART OSR2:"
```

```r
OSR2(predcart_us, test_us$suicides.100k.pop, train_us$suicides.100k.pop)
```

```
## [1] 0.9883818
```

Random Forest

```r
set.seed(377)

mod.rf.us <- randomForest(suicides.100k.pop ~ ., data = train_us, mtry = 5, nodesize = 5, ntree = 500)
```

```r
pred.rf.us <- predict(mod.rf.us, newdata = test_us) # just to illustrate
pred.rf.us[1:5]
```

```
##         1         7        16        21        26
##  4.859536  1.050132 24.295192  7.247386 20.566757
```

```r
importance(mod.rf.us)
```

```
##                        IncNodePurity
## year                        721.5390
## sex                        6873.8985
## suicides_no               20017.7699
## population                12227.8713
## HDI.for.year                248.8317
## gdp_for_year....            268.8887
## gdp_per_capita....          222.9683
## generation                 2319.3296
## depression_percentage      4389.2658
## drug_death_rate            1101.7067
```

```r
set.seed(377)
train.rf.us <- train(suicides.100k.pop ~ .,
                     data = train_us,
                     method = "rf",
                     tuneGrid = data.frame(mtry=1:5),
                     trControl = trainControl(method="cv", number=5, verboseIter = TRUE),
                     metric = "RMSE")
```

```
## + Fold1: mtry=1
## - Fold1: mtry=1
## + Fold1: mtry=2
## - Fold1: mtry=2
## + Fold1: mtry=3
## - Fold1: mtry=3
## + Fold1: mtry=4
## - Fold1: mtry=4
## + Fold1: mtry=5
## - Fold1: mtry=5
## + Fold2: mtry=1
## - Fold2: mtry=1
## + Fold2: mtry=2
## - Fold2: mtry=2
## + Fold2: mtry=3
## - Fold2: mtry=3
## + Fold2: mtry=4
## - Fold2: mtry=4
## + Fold2: mtry=5
## - Fold2: mtry=5
## + Fold3: mtry=1
```

```
## - Fold3: mtry=1
## + Fold3: mtry=2
## - Fold3: mtry=2
## + Fold3: mtry=3
## - Fold3: mtry=3
## + Fold3: mtry=4
## - Fold3: mtry=4
## + Fold3: mtry=5
## - Fold3: mtry=5
## + Fold4: mtry=1
## - Fold4: mtry=1
## + Fold4: mtry=2
## - Fold4: mtry=2
## + Fold4: mtry=3
## - Fold4: mtry=3
## + Fold4: mtry=4
## - Fold4: mtry=4
## + Fold4: mtry=5
## - Fold4: mtry=5
## + Fold5: mtry=1
## - Fold5: mtry=1
## + Fold5: mtry=2
## - Fold5: mtry=2
## + Fold5: mtry=3
## - Fold5: mtry=3
## + Fold5: mtry=4
## - Fold5: mtry=4
## + Fold5: mtry=5
## - Fold5: mtry=5
## Aggregating results
## Selecting tuning parameters
## Fitting mtry = 5 on full training set
```

```
train.rf.us$results
```

```
##   mtry     RMSE  Rsquared      MAE    RMSESD  RsquaredSD     MAESD
## 1    1 9.824508 0.8696212 7.994422 0.9381334 0.040652349 0.5209140
## 2    2 6.502285 0.9248426 4.913252 0.8379313 0.007879139 0.4761299
## 3    3 4.769440 0.9495409 3.396341 0.7533864 0.010192692 0.4333536
## 4    4 3.711369 0.9646292 2.495179 0.6784323 0.007789490 0.3832441
## 5    5 3.069317 0.9735388 2.018823 0.5291298 0.005027661 0.3227183
```

```
best.rf.us <- train.rf.us$finalModel
```

```
us.test_rf = as.data.frame(model.matrix(suicides.100k.pop ~ . + 0, data = test_us))
```

```
pred.best.rf_us <- predict(best.rf.us, newdata = us.test_rf)
pred.best.rf_us[1:5]
```

```
##         1         7        16         21        26
##  6.398268  3.707426 23.008092  7.826827 21.054450
```

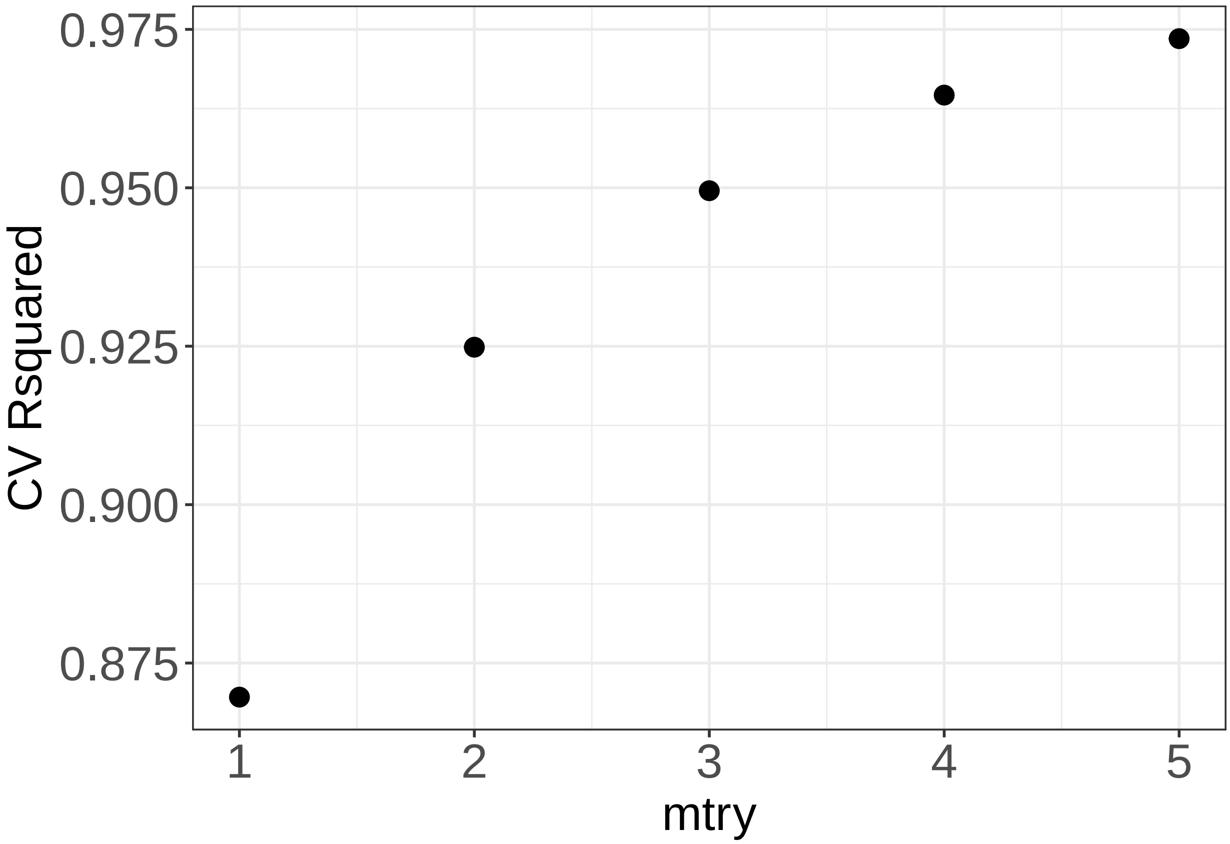
```
print("Random Forests OSR2:")
```

```
## [1] "Random Forests OSR2:"
```

```r
OSR2(pred.best.rf_us, test_us$suicides.100k.pop, train_us$suicides.100k.pop)
```

```
## [1] 0.9645385
```

```r
ggplot(train.rf.us$results, aes(x = mtry, y = Rsquared)) + geom_point(size = 3) +
  ylab("CV Rsquared") + theme_bw() + theme(axis.title=element_text(size=18), axis.text=element_text(siz
```



mtry = 10

```r
set.seed(377)
train.rf.us_mtryTen <- train(suicides.100k.pop ~ .,
                             data = train_us,
                             method = "rf",
                             tuneGrid = data.frame(mtry=1:10),
                             trControl = trainControl(method="cv", number=5, verboseIter = TRUE),
                             metric = "RMSE")
```

```
## + Fold1: mtry= 1
## - Fold1: mtry= 1
## + Fold1: mtry= 2
## - Fold1: mtry= 2
## + Fold1: mtry= 3
## - Fold1: mtry= 3
## + Fold1: mtry= 4
## - Fold1: mtry= 4
## + Fold1: mtry= 5
```

```
## - Fold1: mtry= 5
## + Fold1: mtry= 6
## - Fold1: mtry= 6
## + Fold1: mtry= 7
## - Fold1: mtry= 7
## + Fold1: mtry= 8
## - Fold1: mtry= 8
## + Fold1: mtry= 9
## - Fold1: mtry= 9
## + Fold1: mtry=10
## - Fold1: mtry=10
## + Fold2: mtry= 1
## - Fold2: mtry= 1
## + Fold2: mtry= 2
## - Fold2: mtry= 2
## + Fold2: mtry= 3
## - Fold2: mtry= 3
## + Fold2: mtry= 4
## - Fold2: mtry= 4
## + Fold2: mtry= 5
## - Fold2: mtry= 5
## + Fold2: mtry= 6
## - Fold2: mtry= 6
## + Fold2: mtry= 7
## - Fold2: mtry= 7
## + Fold2: mtry= 8
## - Fold2: mtry= 8
## + Fold2: mtry= 9
## - Fold2: mtry= 9
## + Fold2: mtry=10
## - Fold2: mtry=10
## + Fold3: mtry= 1
## - Fold3: mtry= 1
## + Fold3: mtry= 2
## - Fold3: mtry= 2
## + Fold3: mtry= 3
## - Fold3: mtry= 3
## + Fold3: mtry= 4
## - Fold3: mtry= 4
## + Fold3: mtry= 5
## - Fold3: mtry= 5
## + Fold3: mtry= 6
## - Fold3: mtry= 6
## + Fold3: mtry= 7
## - Fold3: mtry= 7
## + Fold3: mtry= 8
## - Fold3: mtry= 8
## + Fold3: mtry= 9
## - Fold3: mtry= 9
## + Fold3: mtry=10
## - Fold3: mtry=10
## + Fold4: mtry= 1
## - Fold4: mtry= 1
## + Fold4: mtry= 2
```

```
## - Fold4: mtry= 2
## + Fold4: mtry= 3
## - Fold4: mtry= 3
## + Fold4: mtry= 4
## - Fold4: mtry= 4
## + Fold4: mtry= 5
## - Fold4: mtry= 5
## + Fold4: mtry= 6
## - Fold4: mtry= 6
## + Fold4: mtry= 7
## - Fold4: mtry= 7
## + Fold4: mtry= 8
## - Fold4: mtry= 8
## + Fold4: mtry= 9
## - Fold4: mtry= 9
## + Fold4: mtry=10
## - Fold4: mtry=10
## + Fold5: mtry= 1
## - Fold5: mtry= 1
## + Fold5: mtry= 2
## - Fold5: mtry= 2
## + Fold5: mtry= 3
## - Fold5: mtry= 3
## + Fold5: mtry= 4
## - Fold5: mtry= 4
## + Fold5: mtry= 5
## - Fold5: mtry= 5
## + Fold5: mtry= 6
## - Fold5: mtry= 6
## + Fold5: mtry= 7
## - Fold5: mtry= 7
## + Fold5: mtry= 8
## - Fold5: mtry= 8
## + Fold5: mtry= 9
## - Fold5: mtry= 9
## + Fold5: mtry=10
## - Fold5: mtry=10
## Aggregating results
## Selecting tuning parameters
## Fitting mtry = 10 on full training set
```

```
train.rf.us_mtryTen$results
```

```
##    mtry     RMSE  Rsquared      MAE    RMSESD  RsquaredSD     MAESD
## 1     1 9.882207 0.8543650 8.035307 1.0023155 0.036784552 0.6113408
## 2     2 6.620567 0.9187419 4.985777 0.9989036 0.023054109 0.5563487
## 3     3 4.875914 0.9456037 3.456866 0.7017972 0.007218984 0.4125931
## 4     4 3.752569 0.9659937 2.568780 0.6596917 0.006132700 0.3727510
## 5     5 3.000041 0.9743157 1.975137 0.5458457 0.005464792 0.3490734
## 6     6 2.617097 0.9784615 1.669313 0.5002927 0.004488329 0.3125495
## 7     7 2.349818 0.9807843 1.408615 0.4467046 0.006388239 0.2691800
## 8     8 2.211275 0.9820666 1.316461 0.3986787 0.005339521 0.2288858
## 9     9 1.990433 0.9844981 1.167108 0.4789708 0.007932799 0.2326738
## 10   10 1.889257 0.9860799 1.087407 0.3959739 0.005604698 0.2008353
```

```r
best.rf.us_mtryTen <- train.rf.us_mtryTen$finalModel
```

```r
pred.best.rf_us_mtryTen <- predict(best.rf.us_mtryTen, newdata = us.test_rf)
pred.best.rf_us_mtryTen[1:5]
```

```
##         1         7        16        21        26
##  5.047776  1.655800 24.156776  7.160834 20.078536
```

```r
print("Random Forests OSR2:")
```

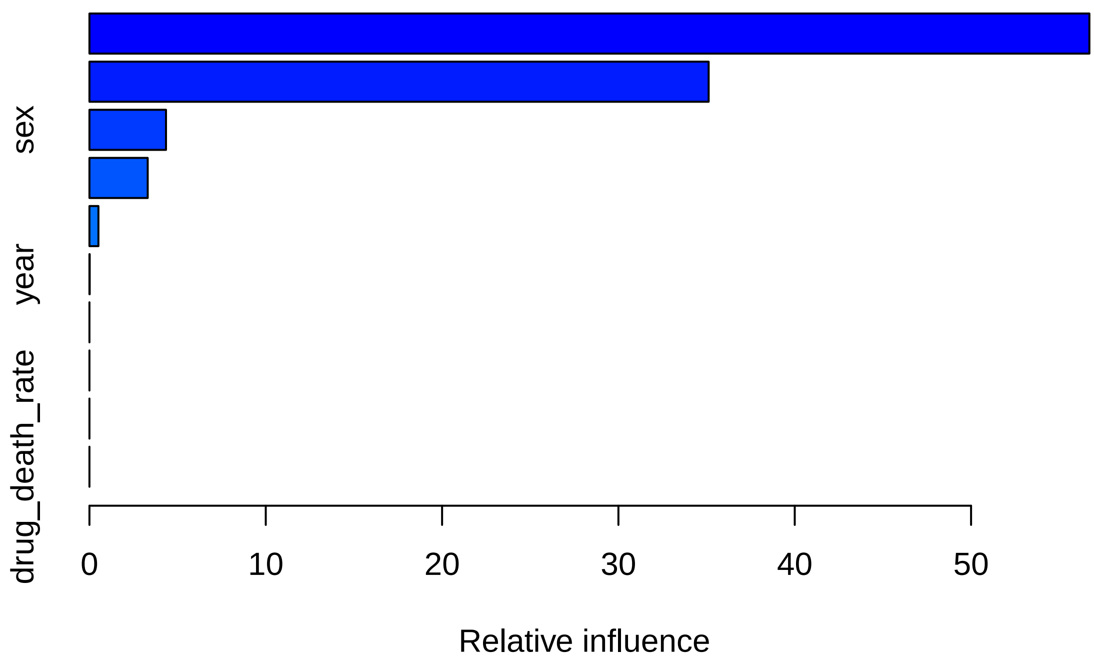
```
## [1] "Random Forests OSR2:"
```

```r
OSR2(pred.best.rf_us_mtryTen, test_us$suicides.100k.pop, train_us$suicides.100k.pop)
```

```
## [1] 0.9928406
```

Boosting

```r
mod.boost <- gbm(suicides.100k.pop ~ .,
                 data = train_us,
                 distribution = "gaussian",
                 n.trees = 1000,
                 shrinkage = 0.001,
                 interaction.depth = 2)
summary(mod.boost)
```




```
##                                            var     rel.inf
## suicides_no                        suicides_no 56.71060064
## population                          population 35.11841374
## sex                                        sex  4.34138880
## depression_percentage depression_percentage  3.30468990
## generation                          generation  0.51025724
## year                                      year  0.01464967
```

```
## HDI.for.year                    HDI.for.year  0.00000000
## gdp_for_year....           gdp_for_year....  0.00000000
## gdp_per_capita....       gdp_per_capita....  0.00000000
## drug_death_rate             drug_death_rate  0.00000000
```

```
pred.boost <- predict(mod.boost, newdata = test_us, n.trees=1000)
OSR2(pred.boost, test_us$suicides.100k.pop, train_us$suicides.100k.pop)
```

```
## [1] 0.7628486
```

```
## took a while to run -- not super amazing OSR^2
# test_us_mm = as.data.frame(model.matrix(suicides.100k.pop ~ . + 0, data = test_us))
#
# gbmGrid <-  expand.grid(interaction.depth = c(1,2,4,6,8,10),
#                         n.trees = (1:75)*500,
#                         shrinkage = 0.001,
#                         n.minobsinnode = 10)
# fitControl <- trainControl(## 10-fold CV
#                            method = "repeatedcv",
#                            number = 5,
#                            ## repeated ten times
#                            repeats = 5)
# set.seed(377)
# gbmFit2 <- train(suicides.100k.pop ~ ., data = train_us,
#                  method = "gbm",
#                  trControl = fitControl,
#                  verbose = FALSE,
#                  tuneGrid = gbmGrid)
#
# gbm.best <- gbmFit2$finalModel
# gbm.pred.best.boost <- predict(gbm.best, newdata = test_us_mm, n.trees = 11500)
# OSR2(gbm.pred.best.boost, test_us$suicides.100k.pop, train_us$suicides.100k.pop)
```

```
## same results as above
# tGrid = expand.grid(n.trees = 1000, interaction.depth = 2, shrinkage = 0.001, n.minobsinnode = 10)tGr
#
# set.seed(377)
# train.boost <- train(suicides.100k.pop ~ .,
#                      data = train_us,
#                      method = "gbm",
#                      tuneGrid = tGrid,
#                      trControl = trainControl(method="cv", number=5,
#                                               verboseIter = FALSE),
#                      metric = "RMSE",
#                      distribution = "gaussian",
#                      verbose = FALSE)
# train.boost
# best.boost <- train.boost$finalModel
# pred.best.boost <- predict(best.boost, newdata = test_us_mm, n.trees = 11500) # can use same model ma
#
# ggplot(train.boost$results, aes(x = n.trees, y = Rsquared, colour = as.factor(interaction.depth))) + 
#   ylab("CV Rsquared") + theme_bw() + theme(axis.title=element_text(size=18), axis.text=element_text(s
#   scale_color_discrete(name = "interaction.depth")
```

```
# OSR2(pred.best.boost, test_us$suicides.100k.pop, train_us$suicides.100k.pop)
# #Out-of-sample MAE:
```

```r
# sum(abs(test_us$suicides.100k.pop - pred.best.boost))/nrow(test_us_mm)
```