

# Lab 3 Revised: Regression Competition

In the hot New Jersey night

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---

## Fit Model and Calculate MSE

```
library(dplyr)

##
## 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

library(MASS)

##
## Attaching package: 'MASS'
##
## The following object is masked from 'package:dplyr':
##
##   select

d <- read.csv("http://andrewpbray.github.io/data/crime-train.csv")

d_cleaned <- data.frame("blank" = rep(0, nrow(d)))
counter <- 1

for(i in 5:ncol(d)){
  if(d[1, i] != "?"){
    d_cleaned[[counter]] <- d[[i]]
    colnames(d_cleaned)[counter] <- colnames(d)[i]
    counter <- counter + 1
  }
}

group_A_automated_fit<- function(training_data) {

m1 <- lm(ViolentCrimesPerPop ~ racePctWhite +
         racePctHisp + pctWSocSec
         + indianPerCap + PctLess9thGrade
         + PctNotHSGrad + PctEmploy
         + PctEmplProfServ + MalePctDivorce
         + FemalePctDiv + PctWorkMom
         + PctIlleg + PctImmigRec5
         + PctImmigRec8 + PctImmigRec10
```

```

      + PctVacantBoarded + PctVacMore6Mos
      + PctHousNoPhone + MedRent
      + MedRentPctHousInc + RentLowQ
      + MedOwnCostPctIncNoMtg + NumStreet
      + pctUrban + PctHousOccup, d_cleaned)
m1
}

m1 <- group_A_automated_fit(d_cleaned)

group_A_process <- function(training_data) {
  training_data %>%
    mutate(sqrtcrime = sqrt(ViolentCrimesPerPop))
}

group_A_MSE <- function(model, data) {
  group_A_process(data)
  MSE <- mean(data$ViolentCrimesPerPop - predict(model, data)^2)
  MSE
}
group_A_MSE(m1, d_cleaned)

## [1] 0.1427261

```

## Forward Selection

```

library(leaps)

r1 <- regsubsets(ViolentCrimesPerPop ~ ., data = d_cleaned, nvmax = 25, method = "forward")
r1

## Subset selection object
## Call: regsubsets.formula(ViolentCrimesPerPop ~ ., data = d_cleaned,
##   nvmax = 25, method = "forward")
## 100 Variables (and intercept)
##
##               Forced in Forced out
## population          FALSE      FALSE
## householdsize        FALSE      FALSE
## racepctblack          FALSE      FALSE
## racePctWhite          FALSE      FALSE
## racePctAsian          FALSE      FALSE
## racePctHisp           FALSE      FALSE
## agePct12t21           FALSE      FALSE
## agePct12t29           FALSE      FALSE
## agePct16t24           FALSE      FALSE
## agePct65up            FALSE      FALSE
## numbUrban             FALSE      FALSE
## pctUrban              FALSE      FALSE
## medIncome             FALSE      FALSE

```

## pctWWage	FALSE	FALSE
## pctWFarmSelf	FALSE	FALSE
## pctWInvInc	FALSE	FALSE
## pctWSocSec	FALSE	FALSE
## pctWPubAsst	FALSE	FALSE
## pctWRetire	FALSE	FALSE
## medFamInc	FALSE	FALSE
## perCapInc	FALSE	FALSE
## whitePerCap	FALSE	FALSE
## blackPerCap	FALSE	FALSE
## indianPerCap	FALSE	FALSE
## AsianPerCap	FALSE	FALSE
## OtherPerCap	FALSE	FALSE
## HispPerCap	FALSE	FALSE
## NumUnderPov	FALSE	FALSE
## PctPopUnderPov	FALSE	FALSE
## PctLess9thGrade	FALSE	FALSE
## PctNotHSGrad	FALSE	FALSE
## PctBSorMore	FALSE	FALSE
## PctUnemployed	FALSE	FALSE
## PctEmploy	FALSE	FALSE
## PctEmplManu	FALSE	FALSE
## PctEmplProfServ	FALSE	FALSE
## PctOccupManu	FALSE	FALSE
## PctOccupMgmtProf	FALSE	FALSE
## MalePctDivorce	FALSE	FALSE
## MalePctNevMarr	FALSE	FALSE
## FemalePctDiv	FALSE	FALSE
## TotalPctDiv	FALSE	FALSE
## PersPerFam	FALSE	FALSE
## PctFam2Par	FALSE	FALSE
## PctKids2Par	FALSE	FALSE
## PctYoungKids2Par	FALSE	FALSE
## PctTeen2Par	FALSE	FALSE
## PctWorkMomYoungKids	FALSE	FALSE
## PctWorkMom	FALSE	FALSE
## NumIlleg	FALSE	FALSE
## PctIlleg	FALSE	FALSE
## NumImmig	FALSE	FALSE
## PctImmigRecent	FALSE	FALSE
## PctImmigRec5	FALSE	FALSE
## PctImmigRec8	FALSE	FALSE
## PctImmigRec10	FALSE	FALSE
## PctRecentImmig	FALSE	FALSE
## PctRecImmig5	FALSE	FALSE
## PctRecImmig8	FALSE	FALSE
## PctRecImmig10	FALSE	FALSE
## PctSpeakEnglOnly	FALSE	FALSE
## PctNotSpeakEnglWell	FALSE	FALSE
## PctLargHouseFam	FALSE	FALSE
## PctLargHouseOccup	FALSE	FALSE
## PersPerOccupHous	FALSE	FALSE
## PersPerOwnOccHous	FALSE	FALSE
## PersPerRentOccHous	FALSE	FALSE

```

## PctPersOwnOccup      FALSE      FALSE
## PctPersDenseHous     FALSE      FALSE
## PctHousLess3BR       FALSE      FALSE
## MedNumBR             FALSE      FALSE
## HousVacant           FALSE      FALSE
## PctHousOccup         FALSE      FALSE
## PctHousOwnOcc        FALSE      FALSE
## PctVacantBoarded     FALSE      FALSE
## PctVacMore6Mos       FALSE      FALSE
## MedYrHousBuilt       FALSE      FALSE
## PctHousNoPhone       FALSE      FALSE
## PctWOFullPlumb       FALSE      FALSE
## OwnOccLowQuart       FALSE      FALSE
## OwnOccMedVal         FALSE      FALSE
## OwnOccHiQuart        FALSE      FALSE
## RentLowQ             FALSE      FALSE
## RentMedian           FALSE      FALSE
## RentHighQ            FALSE      FALSE
## MedRent              FALSE      FALSE
## MedRentPctHousInc    FALSE      FALSE
## MedOwnCostPctInc     FALSE      FALSE
## MedOwnCostPctIncNoMtg FALSE      FALSE
## NumInShelters        FALSE      FALSE
## NumStreet            FALSE      FALSE
## PctForeignBorn        FALSE      FALSE
## PctBornSameState     FALSE      FALSE
## PctSameHouse85       FALSE      FALSE
## PctSameCity85        FALSE      FALSE
## PctSameState85       FALSE      FALSE
## LandArea             FALSE      FALSE
## PopDens              FALSE      FALSE
## PctUsePubTrans       FALSE      FALSE
## LemasPctOfficDrugUn  FALSE      FALSE
## 1 subsets of each size up to 25
## Selection Algorithm: forward

```

```
attributes(r1)
```

```

## $names
## [1] "np"      "nrbar"    "d"        "rbar"     "thetab"
## [6] "first"   "last"     "vorder"   "tol"      "rss"
## [11] "bound"   "nvmax"    "ress"     "ir"       "nbest"
## [16] "lopt"    "il"       "ier"      "xnames"   "method"
## [21] "force.in" "force.out" "sserr"    "intercept" "lindep"
## [26] "nullrss" "nn"       "call"
##
## $class
## [1] "regsubsets"

```

```
str(r1)
```

```

## List of 28
## $ np      : int 101
## $ nrbar   : int 5050
## $ d       : num [1:101] 800 39.8 17.3 16.7 11.7 ...
## $ rbar    : num [1:5050] 0.2432 0.4918 0.7569 0.0303 0.5074 ...

```



```
summary.out <- summary(r1)
as.data.frame(summary.out$outmat)
```

```
##           population householdsize racepctblack racePctWhite racePctAsian
## 1  ( 1 )
## 2  ( 1 )
## 3  ( 1 )
## 4  ( 1 )
## 5  ( 1 )
## 6  ( 1 )
## 7  ( 1 )
## 8  ( 1 )
## 9  ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##           racePctHisp agePct12t21 agePct12t29 agePct16t24 agePct65up
## 1  ( 1 )
## 2  ( 1 )
## 3  ( 1 )
## 4  ( 1 )
## 5  ( 1 )
## 6  ( 1 )
## 7  ( 1 )
## 8  ( 1 )
## 9  ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
```

```

## 25 ( 1 )      *
##      numbUrban pctUrban medIncome pctWWage pctWFarmSelf pctWInvInc
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )      *
## 7 ( 1 )      *
## 8 ( 1 )      *
## 9 ( 1 )      *
## 10 ( 1 )     *
## 11 ( 1 )     *
## 12 ( 1 )     *
## 13 ( 1 )     *
## 14 ( 1 )     *
## 15 ( 1 )     *
## 16 ( 1 )     *
## 17 ( 1 )     *
## 18 ( 1 )     *
## 19 ( 1 )     *
## 20 ( 1 )     *
## 21 ( 1 )     *
## 22 ( 1 )     *
## 23 ( 1 )     *
## 24 ( 1 )     *
## 25 ( 1 )     *
##      pctWSocSec pctWPubAsst pctWRetire medFamInc perCapInc
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )     *
## 17 ( 1 )     *
## 18 ( 1 )     *
## 19 ( 1 )     *
## 20 ( 1 )     *
## 21 ( 1 )     *
## 22 ( 1 )     *
## 23 ( 1 )     *
## 24 ( 1 )     *
## 25 ( 1 )     *
##      whitePerCap blackPerCap indianPerCap AsianPerCap OtherPerCap

```

```

## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##
HispPerCap NumUnderPov PctPopUnderPov PctLess9thGrade
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##
PctNotHSGrad PctBSorMore PctUnemployed PctEmploy PctEmplManu
## 1 ( 1 )
## 2 ( 1 )

```



## 3	( 1 )			
## 4	( 1 )			
## 5	( 1 )			*
## 6	( 1 )			*
## 7	( 1 )			*
## 8	( 1 )			*
## 9	( 1 )			*
## 10	( 1 )			*
## 11	( 1 )			*
## 12	( 1 )	*		*
## 13	( 1 )	*		*
## 14	( 1 )	*		*
## 15	( 1 )	*		*
## 16	( 1 )	*		*
## 17	( 1 )	*		*
## 18	( 1 )	*		*
## 19	( 1 )	*		*
## 20	( 1 )	*		*
## 21	( 1 )	*		*
## 22	( 1 )	*		*
## 23	( 1 )	*		*
## 24	( 1 )	*		*
## 25	( 1 )	*		*
##		PctEmplProfServ	PctOccupManu	PctOccupMgmtProf
## 1	( 1 )			MalePctDivorce
## 2	( 1 )			
## 3	( 1 )			
## 4	( 1 )			
## 5	( 1 )			
## 6	( 1 )			
## 7	( 1 )			*
## 8	( 1 )			*
## 9	( 1 )			*
## 10	( 1 )			*
## 11	( 1 )			*
## 12	( 1 )			*
## 13	( 1 )			*
## 14	( 1 )			*
## 15	( 1 )			*
## 16	( 1 )			*
## 17	( 1 )			*
## 18	( 1 )			*
## 19	( 1 )			*
## 20	( 1 )			*
## 21	( 1 )			*
## 22	( 1 )			*
## 23	( 1 )			*
## 24	( 1 )	*		*
## 25	( 1 )	*		*
##		MalePctNevMarr	FemalePctDiv	TotalPctDiv
## 1	( 1 )			PersPerFam
## 2	( 1 )			PctFam2Par
## 3	( 1 )			
## 4	( 1 )			

```

## 5 ( 1 ) *
## 6 ( 1 ) *
## 7 ( 1 ) *
## 8 ( 1 ) *
## 9 ( 1 ) *
## 10 ( 1 ) *
## 11 ( 1 ) *
## 12 ( 1 ) *
## 13 ( 1 ) *
## 14 ( 1 ) *
## 15 ( 1 ) *
## 16 ( 1 ) *
## 17 ( 1 ) *
## 18 ( 1 ) *
## 19 ( 1 ) *
## 20 ( 1 ) *
## 21 ( 1 ) *
## 22 ( 1 ) *
## 23 ( 1 ) *
## 24 ( 1 ) *
## 25 ( 1 ) *
##      PctKids2Par PctYoungKids2Par PctTeen2Par PctWorkMomYoungKids
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PctWorkMom NumIlleg PctIlleg NumImmig PctImmigRecent
## 1 ( 1 ) *
## 2 ( 1 ) *
## 3 ( 1 ) *
## 4 ( 1 ) *
## 5 ( 1 ) *
## 6 ( 1 ) *

```

```

## 7 ( 1 ) *
## 8 ( 1 ) *
## 9 ( 1 ) *
## 10 ( 1 ) *
## 11 ( 1 ) *
## 12 ( 1 ) *
## 13 ( 1 ) *
## 14 ( 1 ) *
## 15 ( 1 ) *
## 16 ( 1 ) *
## 17 ( 1 ) *
## 18 ( 1 ) *
## 19 ( 1 ) *
## 20 ( 1 ) *
## 21 ( 1 ) *
## 22 ( 1 ) *
## 23 ( 1 ) *
## 24 ( 1 ) *
## 25 ( 1 ) *
## PctImmigRec5 PctImmigRec8 PctImmigRec10 PctRecentImmig
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 ) *
## 18 ( 1 ) *
## 19 ( 1 ) *
## 20 ( 1 ) *
## 21 ( 1 ) * *
## 22 ( 1 ) * *
## 23 ( 1 ) * *
## 24 ( 1 ) * *
## 25 ( 1 ) * *
## PctRecImmig5 PctRecImmig8 PctRecImmig10 PctSpeakEnglOnly
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )

```

```

## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PctNotSpeakEnglWell PctLargHouseFam PctLargHouseOccup
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PersPerOccupHous PersPerOwnOccHous PersPerRentOccHous
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )

```

```

## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PctPersOwnOccup PctPersDenseHous PctHousLess3BR MedNumBR
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      HousVacant PctHousOccup PctHousOwnOcc PctVacantBoarded
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )

```

```

## 13 ( 1 )      *      *
## 14 ( 1 )      *      *
## 15 ( 1 )      *      *
## 16 ( 1 )      *      *
## 17 ( 1 )      *      *
## 18 ( 1 )      *      *
## 19 ( 1 )      *      *
## 20 ( 1 )      *      *
## 21 ( 1 )      *      *
## 22 ( 1 )      *      *
## 23 ( 1 )      *      *
## 24 ( 1 )      *      *
## 25 ( 1 )      *      *
##      PctVacMore6Mos MedYrHousBuilt PctHousNoPhone PctWOFullPlumb
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )      *
## 23 ( 1 )      *
## 24 ( 1 )      *
## 25 ( 1 )      *      *
##      OwnOccLowQuart OwnOccMedVal OwnOccHiQuart RentLowQ RentMedian
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )      *

```

## 15	( 1 )				*
## 16	( 1 )				*
## 17	( 1 )				*
## 18	( 1 )				*
## 19	( 1 )				*
## 20	( 1 )				*
## 21	( 1 )				*
## 22	( 1 )				*
## 23	( 1 )				*
## 24	( 1 )				*
## 25	( 1 )				*
##		RentHighQ	MedRent	MedRentPctHousInc	MedOwnCostPctInc
## 1	( 1 )				
## 2	( 1 )				
## 3	( 1 )				
## 4	( 1 )				
## 5	( 1 )				
## 6	( 1 )				
## 7	( 1 )				
## 8	( 1 )				
## 9	( 1 )				
## 10	( 1 )				
## 11	( 1 )				
## 12	( 1 )				
## 13	( 1 )		*		
## 14	( 1 )		*		
## 15	( 1 )		*	*	
## 16	( 1 )		*	*	
## 17	( 1 )		*	*	
## 18	( 1 )		*	*	
## 19	( 1 )		*	*	
## 20	( 1 )		*	*	
## 21	( 1 )		*	*	
## 22	( 1 )		*	*	
## 23	( 1 )		*	*	
## 24	( 1 )		*	*	
## 25	( 1 )		*	*	
##		MedOwnCostPctIncNoMtg	NumInShelters	NumStreet	PctForeignBorn
## 1	( 1 )				
## 2	( 1 )				
## 3	( 1 )				
## 4	( 1 )				*
## 5	( 1 )				*
## 6	( 1 )				*
## 7	( 1 )				*
## 8	( 1 )				*
## 9	( 1 )				*
## 10	( 1 )				*
## 11	( 1 )		*		*
## 12	( 1 )		*		*
## 13	( 1 )		*		*
## 14	( 1 )		*		*
## 15	( 1 )		*		*
## 16	( 1 )		*		*

```

## 17 ( 1 )      *      *
## 18 ( 1 )      *      *
## 19 ( 1 )      *      *
## 20 ( 1 )      *      *
## 21 ( 1 )      *      *
## 22 ( 1 )      *      *
## 23 ( 1 )      *      *
## 24 ( 1 )      *      *
## 25 ( 1 )      *      *
##      PctBornSameState PctSameHouse85 PctSameCity85 PctSameState85
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      LandArea PopDens PctUsePubTrans LemasPctOfficDrugUn
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )

```



```
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
```

```
which.max(summary.out$adjr2)
```

```
## [1] 25
```

```
summary.out$which[25,]
```

##	(Intercept)	population	householdsize
##	TRUE	FALSE	FALSE
##	racepctblack	racePctWhite	racePctAsian
##	FALSE	TRUE	FALSE
##	racePctHisp	agePct12t21	agePct12t29
##	TRUE	FALSE	FALSE
##	agePct16t24	agePct65up	numbUrban
##	FALSE	FALSE	FALSE
##	pctUrban	medIncome	pctWWage
##	TRUE	FALSE	FALSE
##	pctWFarmSelf	pctWInvInc	pctWSocSec
##	FALSE	FALSE	TRUE
##	pctWPubAsst	pctWRetire	medFamInc
##	FALSE	FALSE	FALSE
##	perCapInc	whitePerCap	blackPerCap
##	FALSE	FALSE	FALSE
##	indianPerCap	AsianPerCap	OtherPerCap
##	TRUE	FALSE	FALSE
##	HispPerCap	NumUnderPov	PctPopUnderPov
##	FALSE	FALSE	FALSE
##	PctLess9thGrade	PctNotHSGrad	PctBSorMore
##	TRUE	TRUE	FALSE
##	PctUnemployed	PctEmploy	PctEmplManu
##	FALSE	TRUE	FALSE
##	PctEmplProfServ	PctOccupManu	PctOccupMgmtProf
##	TRUE	FALSE	FALSE
##	MalePctDivorce	MalePctNevMarr	FemalePctDiv
##	TRUE	FALSE	TRUE
##	TotalPctDiv	PersPerFam	PctFam2Par
##	FALSE	FALSE	FALSE
##	PctKids2Par	PctYoungKids2Par	PctTeen2Par
##	FALSE	FALSE	FALSE
##	PctWorkMomYoungKids	PctWorkMom	NumIlleg
##	FALSE	TRUE	FALSE
##	PctIlleg	NumImmig	PctImmigRecent
##	TRUE	FALSE	FALSE
##	PctImmigRec5	PctImmigRec8	PctImmigRec10
##	TRUE	TRUE	TRUE
##	PctRecentImmig	PctRecImmig5	PctRecImmig8
##	FALSE	FALSE	FALSE
##	PctRecImmig10	PctSpeakEnglOnly	PctNotSpeakEnglWell

```
##          FALSE          FALSE          FALSE
##      PctLargHouseFam    PctLargHouseOccup    PersPerOccupHous
##          FALSE          FALSE          FALSE
##      PersPerOwnOccHous    PersPerRentOccHous    PctPersOwnOccup
##          FALSE          FALSE          FALSE
##      PctPersDenseHous    PctHousLess3BR    MedNumBR
##          FALSE          FALSE          FALSE
##          HousVacant    PctHousOccup    PctHousOwnOcc
##          FALSE          TRUE          FALSE
##      PctVacantBoarded    PctVacMore6Mos    MedYrHousBuilt
##          TRUE          TRUE          FALSE
##      PctHousNoPhone    PctWOFullPlumb    OwnOccLowQuart
##          TRUE          FALSE          FALSE
##          OwnOccMedVal    OwnOccHiQuart    RentLowQ
##          FALSE          FALSE          TRUE
##          RentMedian    RentHighQ    MedRent
##          FALSE          FALSE          TRUE
##      MedRentPctHousInc    MedOwnCostPctInc    MedOwnCostPctIncNoMtg
##          TRUE          FALSE          TRUE
##          NumInShelters    NumStreet    PctForeignBorn
##          FALSE          TRUE          FALSE
##      PctBornSameState    PctSameHouse85    PctSameCity85
##          FALSE          FALSE          FALSE
##      PctSameState85    LandArea    PopDens
##          FALSE          FALSE          FALSE
##      PctUsePubTrans    LemasPctOfficDrugUn
##          FALSE          FALSE
```

```
best.model <- lm(ViolentCrimesPerPop ~ racePctWhite + racePctHispanic + pctWSocSec + indianPerCap + PctLess9thGrade + PctNotHSGrad + PctEmploy + PctEmplProfServ + MalePctDivorce + FemalePctDiv + PctWorkMom + PctIlleg + PctImmigRec5 + PctImmigRec8 + PctImmigRec10 + PctVacantBoarded + PctVacMore6Mos + PctHousNoPhone + MedRent + MedRentPctHousInc + RentLowQ + MedOwnCostPctIncNoMtg + NumStreet + pctUrban + PctHousOccup, data = d_cleaned)
```

```
summary(best.model)
```

```
##
## Call:
## lm(formula = ViolentCrimesPerPop ~ racePctWhite + racePctHispanic + pctWSocSec + indianPerCap + PctLess9thGrade + PctNotHSGrad + PctEmploy + PctEmplProfServ + MalePctDivorce + FemalePctDiv + PctWorkMom + PctIlleg + PctImmigRec5 + PctImmigRec8 + PctImmigRec10 + PctVacantBoarded + PctVacMore6Mos + PctHousNoPhone + MedRent + MedRentPctHousInc + RentLowQ + MedOwnCostPctIncNoMtg + NumStreet + pctUrban + PctHousOccup, data = d_cleaned)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.50745 -0.07539 -0.01158  0.05254  0.63131
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.007454   0.093093   0.080 0.936206
## racePctWhite   -0.217587   0.040351  -5.392 9.25e-08 ***
## racePctHispanic  0.071670   0.034060   2.104 0.035684 *
## pctWSocSec      0.169979   0.062461   2.721 0.006647 **
## indianPerCap   -0.062586   0.032145  -1.947 0.051900 .
```

```
## PctLess9thGrade      -0.156711    0.084835   -1.847  0.065094 .
## PctNotHSGrad         0.327993    0.110782    2.961  0.003163 **
## PctEmploy            0.208276    0.082885    2.513  0.012179 *
## PctEmplProfServ      0.068993    0.041896    1.647  0.100010
## MalePctDivorce       0.294348    0.083708    3.516  0.000463 ***
## FemalePctDiv         -0.018782    0.085610   -0.219  0.826409
## PctWorkMom           -0.102374    0.039767   -2.574  0.010227 *
## PctIlleg             0.324441    0.046463    6.983  6.24e-12 ***
## PctImmigRec5         -0.233562    0.074136   -3.150  0.001693 **
## PctImmigRec8         0.386945    0.110547    3.500  0.000491 ***
## PctImmigRec10        -0.112990    0.076586   -1.475  0.140532
## PctVacantBoarded     0.066917    0.030083    2.224  0.026408 *
## PctVacMore6Mos       -0.060606    0.035142   -1.725  0.084998 .
## PctHousNoPhone       -0.056889    0.043824   -1.298  0.194628
## MedRent              0.435922    0.090754    4.803  1.87e-06 ***
## MedRentPctHousInc    0.075303    0.038247    1.969  0.049325 *
## RentLowQ             -0.461313    0.090337   -5.107  4.13e-07 ***
## MedOwnCostPctIncNoMtg -0.109093    0.030841   -3.537  0.000428 ***
## NumStreet            0.190690    0.040275    4.735  2.61e-06 ***
## pctUrban             0.041869    0.013461    3.110  0.001938 **
## PctHousOccup         -0.105796    0.032763   -3.229  0.001294 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1321 on 774 degrees of freedom
## Multiple R-squared:  0.6937, Adjusted R-squared:  0.6838
## F-statistic: 70.13 on 25 and 774 DF,  p-value: < 2.2e-16
```

Adjusted R-squared of best model from forward selection = 0.6838 After comparing, to the best model derived from backward selection, this model has a smaller adjusted R-squared. Consequently, I fitted this model (r1) as m1 above, and derived its MSE.

## BACKWARD SELECTION

```
r2 <- regsubsets(ViolentCrimesPerPop ~ ., data = d_cleaned, nvmax = 25, method = "backward")
```

```
r2
```

```
## Subset selection object
## Call: regsubsets.formula(ViolentCrimesPerPop ~ ., data = d_cleaned,
##     nvmax = 25, method = "backward")
## 100 Variables (and intercept)
##              Forced in Forced out
## population           FALSE      FALSE
## householdsize        FALSE      FALSE
## racepctblack          FALSE      FALSE
## racePctWhite          FALSE      FALSE
## racePctAsian          FALSE      FALSE
## racePctHispanic       FALSE      FALSE
## agePct12t21           FALSE      FALSE
## agePct12t29           FALSE      FALSE
## agePct16t24           FALSE      FALSE
## agePct65up            FALSE      FALSE
## numbUrban             FALSE      FALSE
## pctUrban              FALSE      FALSE
```

## medIncome	FALSE	FALSE
## pctWWage	FALSE	FALSE
## pctWFarmSelf	FALSE	FALSE
## pctWInvInc	FALSE	FALSE
## pctWSocSec	FALSE	FALSE
## pctWPubAsst	FALSE	FALSE
## pctWRetire	FALSE	FALSE
## medFamInc	FALSE	FALSE
## perCapInc	FALSE	FALSE
## whitePerCap	FALSE	FALSE
## blackPerCap	FALSE	FALSE
## indianPerCap	FALSE	FALSE
## AsianPerCap	FALSE	FALSE
## OtherPerCap	FALSE	FALSE
## HispPerCap	FALSE	FALSE
## NumUnderPov	FALSE	FALSE
## PctPopUnderPov	FALSE	FALSE
## PctLess9thGrade	FALSE	FALSE
## PctNotHSGrad	FALSE	FALSE
## PctBSorMore	FALSE	FALSE
## PctUnemployed	FALSE	FALSE
## PctEmploy	FALSE	FALSE
## PctEmplManu	FALSE	FALSE
## PctEmplProfServ	FALSE	FALSE
## PctOccupManu	FALSE	FALSE
## PctOccupMgmtProf	FALSE	FALSE
## MalePctDivorce	FALSE	FALSE
## MalePctNevMarr	FALSE	FALSE
## FemalePctDiv	FALSE	FALSE
## TotalPctDiv	FALSE	FALSE
## PersPerFam	FALSE	FALSE
## PctFam2Par	FALSE	FALSE
## PctKids2Par	FALSE	FALSE
## PctYoungKids2Par	FALSE	FALSE
## PctTeen2Par	FALSE	FALSE
## PctWorkMomYoungKids	FALSE	FALSE
## PctWorkMom	FALSE	FALSE
## NumIlleg	FALSE	FALSE
## PctIlleg	FALSE	FALSE
## NumImmig	FALSE	FALSE
## PctImmigRecent	FALSE	FALSE
## PctImmigRec5	FALSE	FALSE
## PctImmigRec8	FALSE	FALSE
## PctImmigRec10	FALSE	FALSE
## PctRecentImmig	FALSE	FALSE
## PctRecImmig5	FALSE	FALSE
## PctRecImmig8	FALSE	FALSE
## PctRecImmig10	FALSE	FALSE
## PctSpeakEnglOnly	FALSE	FALSE
## PctNotSpeakEnglWell	FALSE	FALSE
## PctLargHouseFam	FALSE	FALSE
## PctLargHouseOccup	FALSE	FALSE
## PersPerOccupHous	FALSE	FALSE
## PersPerOwnOccHous	FALSE	FALSE

```

## PersPerRentOccHous      FALSE      FALSE
## PctPersOwnOccup         FALSE      FALSE
## PctPersDenseHous        FALSE      FALSE
## PctHousLess3BR          FALSE      FALSE
## MedNumBR                FALSE      FALSE
## HousVacant              FALSE      FALSE
## PctHousOccup            FALSE      FALSE
## PctHousOwnOcc           FALSE      FALSE
## PctVacantBoarded        FALSE      FALSE
## PctVacMore6Mos          FALSE      FALSE
## MedYrHousBuilt          FALSE      FALSE
## PctHousNoPhone          FALSE      FALSE
## PctWOFullPlumb          FALSE      FALSE
## OwnOccLowQuart          FALSE      FALSE
## OwnOccMedVal            FALSE      FALSE
## OwnOccHiQuart           FALSE      FALSE
## RentLowQ                FALSE      FALSE
## RentMedian              FALSE      FALSE
## RentHighQ               FALSE      FALSE
## MedRent                 FALSE      FALSE
## MedRentPctHousInc       FALSE      FALSE
## MedOwnCostPctInc        FALSE      FALSE
## MedOwnCostPctIncNoMtg   FALSE      FALSE
## NumInShelters           FALSE      FALSE
## NumStreet               FALSE      FALSE
## PctForeignBorn          FALSE      FALSE
## PctBornSameState        FALSE      FALSE
## PctSameHouse85          FALSE      FALSE
## PctSameCity85           FALSE      FALSE
## PctSameState85          FALSE      FALSE
## LandArea                FALSE      FALSE
## PopDens                 FALSE      FALSE
## PctUsePubTrans          FALSE      FALSE
## LemasPctOfficDrugUn     FALSE      FALSE
## 1 subsets of each size up to 25
## Selection Algorithm: backward

```

```
attributes(r2)
```

```

## $names
## [1] "np"      "nrbar"   "d"       "rbar"    "thetab"
## [6] "first"   "last"    "vorder"  "tol"     "rss"
## [11] "bound"   "nvmax"   "ress"    "ir"      "nbest"
## [16] "lopt"    "il"      "ier"     "xnames"  "method"
## [21] "force.in" "force.out" "sserr"   "intercept" "lindep"
## [26] "nullrss" "nn"      "call"
##
## $class
## [1] "regsubsets"

```

```
str(r2)
```

```

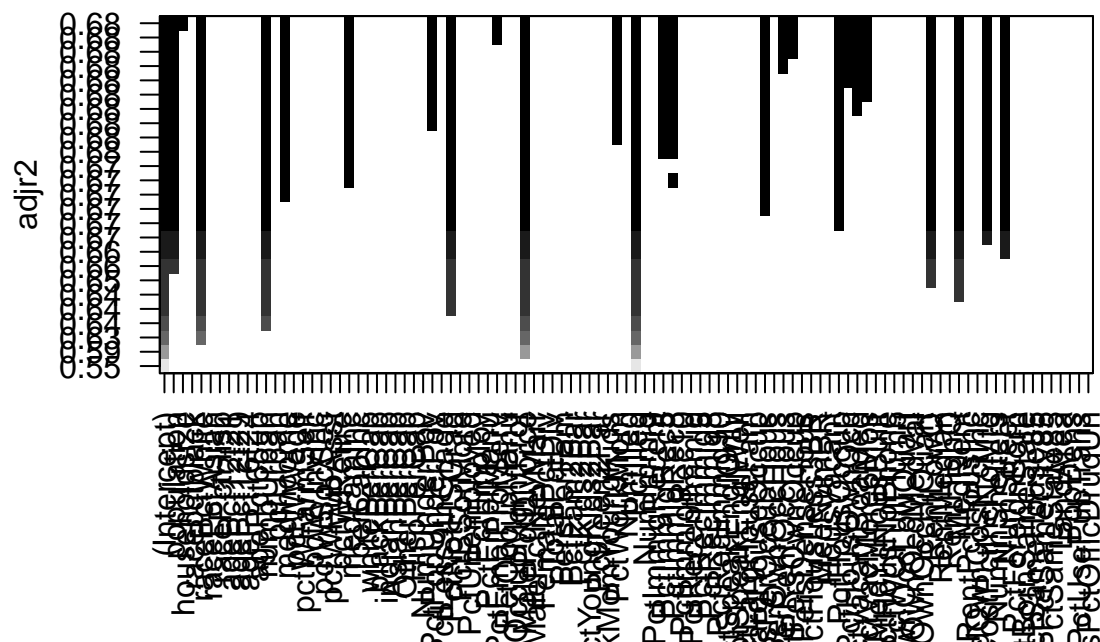
## List of 28
## $ np      : int 101
## $ nrbar   : int 5050
## $ d       : num [1:101] 800 39.8 19.4 16.7 13.7 ...

```

```
## $ rbar      : num [1:5050] 0.2432 0.4657 0.7569 0.0714 0.3781 ...
## $ thetab    : num [1:101] 0.237 0.782 0.31 -0.293 0.176 ...
## $ first     : int 2
## $ last      : int 101
## $ vorder    : int [1:101] 1 52 40 5 12 32 87 84 2 92 ...
## $ tol       : num [1:101] 1.41e-08 1.56e-08 1.70e-08 1.68e-08 3.33e-09 ...
## $ rss       : num [1:101] 44.1 19.7 17.9 16.4 16 ...
## $ bound     : num [1:101] 44.1 38 38 25 20.9 ...
## $ nvmax     : int 26
## $ res       : num [1:101, 1] 44.1 19.7 17.9 16.4 16 ...
## $ ir        : int 26
## $ nbest     : num 1
## $ lopt      : int [1:351, 1] 1 1 52 1 52 40 1 52 40 5 ...
## $ il        : int 351
## $ ier       : int 0
## $ xnames    : chr [1:101] "(Intercept)" "population" "householdsize" "racepctblack" ...
## $ method    : chr "backward"
## $ force.in  : Named logi [1:101] TRUE FALSE FALSE FALSE FALSE FALSE ...
##   .. attr(*, "names")= chr [1:101] "" "population" "householdsize" "racepctblack" ...
## $ force.out : Named logi [1:101] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. attr(*, "names")= chr [1:101] "" "population" "householdsize" "racepctblack" ...
## $ sserr     : num 12.4
## $ intercept: logi TRUE
## $ lindep    : logi [1:101] FALSE FALSE FALSE FALSE FALSE FALSE ...
## $ nullrss   : num 44.1
## $ nn       : int 800
## $ call      : language regsubsets.formula(ViolentCrimesPerPop ~ ., data = d_cleaned, nvmax = 25,
## - attr(*, "class")= chr "regsubsets"
```

```
plot(r2, scale = "adjr2", main = "Adjusted R^2")
```

## Adjusted R<sup>2</sup>



```
summary2.out <- summary(r2)
as.data.frame(summary2.out$outmat)
```

```
##      population householdsize racepctblack racePctWhite racePctAsian
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      racePctHisp agePct12t21 agePct12t29 agePct16t24 agePct65up
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
```

```

## 25 ( 1 )
##      numbUrban pctUrban medIncome pctWWage pctWFarmSelf pctWInvInc
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )      *
## 5 ( 1 )      *
## 6 ( 1 )      *
## 7 ( 1 )      *
## 8 ( 1 )      *
## 9 ( 1 )      *
## 10 ( 1 )     *
## 11 ( 1 )     *
## 12 ( 1 )     *
## 13 ( 1 )     *      *
## 14 ( 1 )     *      *
## 15 ( 1 )     *      *
## 16 ( 1 )     *      *
## 17 ( 1 )     *      *
## 18 ( 1 )     *      *
## 19 ( 1 )     *      *
## 20 ( 1 )     *      *
## 21 ( 1 )     *      *
## 22 ( 1 )     *      *
## 23 ( 1 )     *      *
## 24 ( 1 )     *      *
## 25 ( 1 )     *      *
##      pctWSocSec pctWPubAsst pctWRetire medFamInc perCapInc
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )      *
## 15 ( 1 )      *
## 16 ( 1 )      *
## 17 ( 1 )      *
## 18 ( 1 )      *
## 19 ( 1 )      *
## 20 ( 1 )      *
## 21 ( 1 )      *
## 22 ( 1 )      *
## 23 ( 1 )      *
## 24 ( 1 )      *
## 25 ( 1 )      *
##      whitePerCap blackPerCap indianPerCap AsianPerCap OtherPerCap

```



```

## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      HispPerCap NumUnderPov PctPopUnderPov PctLess9thGrade
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PctNotHSGrad PctBSorMore PctUnemployed PctEmploy PctEmplManu
## 1 ( 1 )
## 2 ( 1 )

```

```

## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )      *
## 6 ( 1 )      *
## 7 ( 1 )      *
## 8 ( 1 )      *
## 9 ( 1 )      *
## 10 ( 1 )     *
## 11 ( 1 )     *
## 12 ( 1 )     *
## 13 ( 1 )     *
## 14 ( 1 )     *
## 15 ( 1 )     *
## 16 ( 1 )     *
## 17 ( 1 )     *
## 18 ( 1 )     *
## 19 ( 1 )     *
## 20 ( 1 )     *
## 21 ( 1 )     *
## 22 ( 1 )     *
## 23 ( 1 )     *
## 24 ( 1 )     *
## 25 ( 1 )     *
##      PctEmplProfServ PctOccupManu PctOccupMgmtProf MalePctDivorce
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )      *
## 4 ( 1 )      *
## 5 ( 1 )      *
## 6 ( 1 )      *
## 7 ( 1 )      *
## 8 ( 1 )      *
## 9 ( 1 )      *
## 10 ( 1 )     *
## 11 ( 1 )     *
## 12 ( 1 )     *
## 13 ( 1 )     *
## 14 ( 1 )     *
## 15 ( 1 )     *
## 16 ( 1 )     *
## 17 ( 1 )     *
## 18 ( 1 )     *
## 19 ( 1 )     *
## 20 ( 1 )     *
## 21 ( 1 )     *
## 22 ( 1 )     *
## 23 ( 1 )     *
## 24 ( 1 )     *      *
## 25 ( 1 )     *      *
##      MalePctNevMarr FemalePctDiv TotalPctDiv PersPerFam PctFam2Par
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )

```

```

## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PctKids2Par PctYoungKids2Par PctTeen2Par PctWorkMomYoungKids
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PctWorkMom NumIlleg PctIlleg NumImmig PctImmigRecent
## 1 ( 1 )      *
## 2 ( 1 )      *
## 3 ( 1 )      *
## 4 ( 1 )      *
## 5 ( 1 )      *
## 6 ( 1 )      *

```

```

## 7 ( 1 ) *
## 8 ( 1 ) *
## 9 ( 1 ) *
## 10 ( 1 ) *
## 11 ( 1 ) *
## 12 ( 1 ) *
## 13 ( 1 ) *
## 14 ( 1 ) *
## 15 ( 1 ) *
## 16 ( 1 ) *
## 17 ( 1 ) *
## 18 ( 1 ) *
## 19 ( 1 ) *
## 20 ( 1 ) *
## 21 ( 1 ) *
## 22 ( 1 ) *
## 23 ( 1 ) *
## 24 ( 1 ) *
## 25 ( 1 ) *
## PctImmigRec5 PctImmigRec8 PctImmigRec10 PctRecentImmig
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 ) *
## 16 ( 1 ) *
## 17 ( 1 ) *
## 18 ( 1 ) *
## 19 ( 1 ) *
## 20 ( 1 ) *
## 21 ( 1 ) *
## 22 ( 1 ) *
## 23 ( 1 ) *
## 24 ( 1 ) *
## 25 ( 1 ) *
## PctRecImmig5 PctRecImmig8 PctRecImmig10 PctSpeakEnglOnly
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )

```

```

## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PctNotSpeakEnglWell PctLargHouseFam PctLargHouseOccup
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      PersPerOccupHous PersPerOwnOccHous PersPerRentOccHous
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )

```

```

## 11 ( 1 )
## 12 ( 1 )      *
## 13 ( 1 )      *
## 14 ( 1 )      *
## 15 ( 1 )      *
## 16 ( 1 )      *
## 17 ( 1 )      *
## 18 ( 1 )      *
## 19 ( 1 )      *
## 20 ( 1 )      *
## 21 ( 1 )      *
## 22 ( 1 )      *
## 23 ( 1 )      *
## 24 ( 1 )      *
## 25 ( 1 )      *
##          PctPersOwnOccup PctPersDenseHous PctHousLess3BR MedNumBR
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )      *
## 24 ( 1 )      *
## 25 ( 1 )      *
##          HousVacant PctHousOccup PctHousOwnOcc PctVacantBoarded
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )      *
## 12 ( 1 )      *

```

## 13	( 1 )	*			
## 14	( 1 )	*			
## 15	( 1 )	*			
## 16	( 1 )	*			
## 17	( 1 )	*			
## 18	( 1 )	*			
## 19	( 1 )	*			*
## 20	( 1 )	*			*
## 21	( 1 )	*	*		*
## 22	( 1 )	*	*		*
## 23	( 1 )	*	*		*
## 24	( 1 )	*	*		*
## 25	( 1 )	*	*		*
##			PctVacMore6Mos	MedYrHousBuilt	PctHousNoPhone PctWOFullPlumb
## 1	( 1 )				
## 2	( 1 )				
## 3	( 1 )				
## 4	( 1 )				
## 5	( 1 )				
## 6	( 1 )				
## 7	( 1 )				
## 8	( 1 )				
## 9	( 1 )				
## 10	( 1 )				
## 11	( 1 )				
## 12	( 1 )				
## 13	( 1 )				
## 14	( 1 )				
## 15	( 1 )				
## 16	( 1 )				
## 17	( 1 )				
## 18	( 1 )				
## 19	( 1 )				
## 20	( 1 )	*			
## 21	( 1 )	*			
## 22	( 1 )	*			
## 23	( 1 )	*			
## 24	( 1 )	*			
## 25	( 1 )	*			
##			OwnOccLowQuart	OwnOccMedVal	OwnOccHiQuart RentLowQ RentMedian
## 1	( 1 )				
## 2	( 1 )				
## 3	( 1 )				
## 4	( 1 )				
## 5	( 1 )				
## 6	( 1 )				
## 7	( 1 )				*
## 8	( 1 )				*
## 9	( 1 )				*
## 10	( 1 )				*
## 11	( 1 )				*
## 12	( 1 )				*
## 13	( 1 )				*
## 14	( 1 )				*

## 15	( 1 )				*
## 16	( 1 )				*
## 17	( 1 )				*
## 18	( 1 )				*
## 19	( 1 )				*
## 20	( 1 )				*
## 21	( 1 )				*
## 22	( 1 )				*
## 23	( 1 )				*
## 24	( 1 )				*
## 25	( 1 )				*
##		RentHighQ	MedRent	MedRentPctHousInc	MedOwnCostPctInc
## 1	( 1 )				
## 2	( 1 )				
## 3	( 1 )				
## 4	( 1 )				
## 5	( 1 )				
## 6	( 1 )		*		
## 7	( 1 )		*		
## 8	( 1 )		*		
## 9	( 1 )		*		
## 10	( 1 )		*		
## 11	( 1 )		*		
## 12	( 1 )		*		
## 13	( 1 )		*		
## 14	( 1 )		*		
## 15	( 1 )		*		
## 16	( 1 )		*		
## 17	( 1 )		*		
## 18	( 1 )		*		
## 19	( 1 )		*		
## 20	( 1 )		*		
## 21	( 1 )		*		
## 22	( 1 )		*		
## 23	( 1 )		*		
## 24	( 1 )		*		
## 25	( 1 )		*		
##		MedOwnCostPctIncNoMtg	NumInShelters	NumStreet	PctForeignBorn
## 1	( 1 )				
## 2	( 1 )				
## 3	( 1 )				
## 4	( 1 )				
## 5	( 1 )				
## 6	( 1 )				
## 7	( 1 )				
## 8	( 1 )				
## 9	( 1 )			*	
## 10	( 1 )	*		*	
## 11	( 1 )	*		*	
## 12	( 1 )	*		*	
## 13	( 1 )	*		*	
## 14	( 1 )	*		*	
## 15	( 1 )	*		*	
## 16	( 1 )	*		*	



```

## 17 ( 1 )      *      *
## 18 ( 1 )      *      *
## 19 ( 1 )      *      *
## 20 ( 1 )      *      *
## 21 ( 1 )      *      *
## 22 ( 1 )      *      *
## 23 ( 1 )      *      *
## 24 ( 1 )      *      *
## 25 ( 1 )      *      *
##      PctBornSameState PctSameHouse85 PctSameCity85 PctSameState85
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
##      LandArea PopDens PctUsePubTrans LemasPctOfficDrugUn
## 1 ( 1 )
## 2 ( 1 )
## 3 ( 1 )
## 4 ( 1 )
## 5 ( 1 )
## 6 ( 1 )
## 7 ( 1 )
## 8 ( 1 )
## 9 ( 1 )
## 10 ( 1 )
## 11 ( 1 )
## 12 ( 1 )
## 13 ( 1 )
## 14 ( 1 )
## 15 ( 1 )
## 16 ( 1 )
## 17 ( 1 )
## 18 ( 1 )

```

```
## 19 ( 1 )
## 20 ( 1 )
## 21 ( 1 )
## 22 ( 1 )
## 23 ( 1 )
## 24 ( 1 )
## 25 ( 1 )
```

```
which.max(summary2.out$adjr2)
```

```
## [1] 25
```

```
summary2.out$which[25,]
```

##	(Intercept)	population	householdsize
##	TRUE	TRUE	TRUE
##	racepctblack	racePctWhite	racePctAsian
##	FALSE	TRUE	FALSE
##	racePctHisp	agePct12t21	agePct12t29
##	FALSE	FALSE	FALSE
##	agePct16t24	agePct65up	numbUrban
##	FALSE	FALSE	TRUE
##	pctUrban	medIncome	pctWWage
##	FALSE	TRUE	FALSE
##	pctWFarmSelf	pctWInvInc	pctWSocSec
##	FALSE	FALSE	FALSE
##	pctWPubAsst	pctWRetire	medFamInc
##	FALSE	FALSE	TRUE
##	perCapInc	whitePerCap	blackPerCap
##	FALSE	FALSE	FALSE
##	indianPerCap	AsianPerCap	OtherPerCap
##	FALSE	FALSE	FALSE
##	HispPerCap	NumUnderPov	PctPopUnderPov
##	FALSE	FALSE	TRUE
##	PctLess9thGrade	PctNotHSGrad	PctBSorMore
##	FALSE	TRUE	FALSE
##	PctUnemployed	PctEmploy	PctEmplManu
##	FALSE	FALSE	FALSE
##	PctEmplProfServ	PctOccupManu	PctOccupMgmtProf
##	TRUE	FALSE	FALSE
##	MalePctDivorce	MalePctNevMarr	FemalePctDiv
##	TRUE	FALSE	FALSE
##	TotalPctDiv	PersPerFam	PctFam2Par
##	FALSE	FALSE	FALSE
##	PctKids2Par	PctYoungKids2Par	PctTeen2Par
##	FALSE	FALSE	FALSE
##	PctWorkMomYoungKids	PctWorkMom	NumIlleg
##	FALSE	TRUE	FALSE
##	PctIlleg	NumImmig	PctImmigRecent
##	TRUE	FALSE	FALSE
##	PctImmigRec5	PctImmigRec8	PctImmigRec10
##	TRUE	TRUE	FALSE
##	PctRecentImmig	PctRecImmig5	PctRecImmig8
##	FALSE	FALSE	FALSE
##	PctRecImmig10	PctSpeakEnglOnly	PctNotSpeakEnglWell

```
##          FALSE          FALSE          FALSE
##      PctLargHouseFam    PctLargHouseOccup    PersPerOccupHous
##          FALSE          FALSE          TRUE
##      PersPerOwnOccHous    PersPerRentOccHous    PctPersOwnOccup
##          FALSE          TRUE          TRUE
##      PctPersDenseHous    PctHousLess3BR    MedNumBR
##          FALSE          FALSE          FALSE
##          HousVacant    PctHousOccup    PctHousOwnOcc
##          FALSE          TRUE          TRUE
##      PctVacantBoarded    PctVacMore6Mos    MedYrHousBuilt
##          TRUE          TRUE          FALSE
##      PctHousNoPhone    PctWOFullPlumb    OwnOccLowQuart
##          FALSE          FALSE          FALSE
##          OwnOccMedVal    OwnOccHiQuart    RentLowQ
##          FALSE          FALSE          TRUE
##          RentMedian    RentHighQ    MedRent
##          FALSE          FALSE          TRUE
##      MedRentPctHousInc    MedOwnCostPctInc    MedOwnCostPctIncNoMtg
##          FALSE          FALSE          TRUE
##          NumInShelters    NumStreet    PctForeignBorn
##          FALSE          TRUE          FALSE
##      PctBornSameState    PctSameHouse85    PctSameCity85
##          FALSE          FALSE          FALSE
##      PctSameState85    LandArea    PopDens
##          FALSE          FALSE          FALSE
##      PctUsePubTrans    LemasPctOfficDrugUn
##          FALSE          FALSE
```

```
best.model2 <- lm(ViolentCrimesPerPop ~ population + householdsize + racePctWhite + numbUrban + medIncome
```

```
summary(best.model2)
```

```
##
## Call:
## lm(formula = ViolentCrimesPerPop ~ population + householdsize +
##      racePctWhite + numbUrban + medIncome + medFamInc + PctPopUnderPov +
##      PctNotHSGrad + PctEmplProfServ + MalePctDivorce + PctWorkMom +
##      PctIlleg + PctImmigRec5 + PctImmigRec8 + PersPerOccupHous +
##      PersPerRentOccHous + PctPersOwnOccup + PctHousOwnOcc + PctHousOccup +
##      PctVacantBoarded + PctVacMore6Mos + RentLowQ + MedRent +
##      MedOwnCostPctIncNoMtg + NumStreet, data = d_cleaned)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.48447 -0.07368 -0.01237  0.04960  0.63255
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.15071    0.09622   1.566 0.117671
## population     -1.38615    0.35954  -3.855 0.000125 ***
## householdsize  -0.12242    0.08268  -1.481 0.139110
## racePctWhite   -0.18795    0.04050  -4.641 4.07e-06 ***
## numbUrban       1.44100    0.35844   4.020 6.38e-05 ***
```

```

## medIncome          -0.84374    0.21501   -3.924 9.47e-05 ***
## medFamInc           0.61736    0.19284    3.201 0.001423 **
## PctPopUnderPov      -0.16914    0.06138   -2.756 0.005998 **
## PctNotHSGrad         0.18574    0.04955    3.748 0.000191 ***
## PctEmplProfServ      0.10191    0.04492    2.269 0.023566 *
## MalePctDivorce       0.31927    0.04959    6.438 2.12e-10 ***
## PctWorkMom          -0.07919    0.03497   -2.265 0.023803 *
## PctIlleg             0.36618    0.04899    7.475 2.10e-13 ***
## PctImmigRec5        -0.20978    0.07305   -2.872 0.004192 **
## PctImmigRec8         0.26156    0.07904    3.309 0.000979 ***
## PersPerOccupHous     0.51625    0.14399    3.585 0.000358 ***
## PersPerRentOccHous  -0.29173    0.11402   -2.559 0.010695 *
## PctPersOwnOccup     -0.77757    0.33847   -2.297 0.021868 *
## PctHousOwnOcc        0.81531    0.33149    2.459 0.014131 *
## PctHousOccup        -0.12117    0.03259   -3.717 0.000216 ***
## PctVacantBoarded     0.07461    0.03124    2.388 0.017176 *
## PctVacMore6Mos      -0.07828    0.03438   -2.277 0.023048 *
## RentLowQ            -0.38895    0.09318   -4.174 3.33e-05 ***
## MedRent              0.52489    0.11228    4.675 3.47e-06 ***
## MedOwnCostPctIncNoMtg -0.10160    0.03087   -3.292 0.001041 **
## NumStreet           0.16899    0.04850    3.485 0.000521 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.132 on 774 degrees of freedom
## Multiple R-squared:  0.6943, Adjusted R-squared:  0.6844
## F-statistic: 70.3 on 25 and 774 DF, p-value: < 2.2e-16

```

The Adjusted R-squared is 0.6844, which is greater than the estimate from the previous model using forward selection. Consequently, I fitted the previous model to calculate the MSE.