TS Project

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December 5, 2016

# 1 Introduction

Since 2014, Yelp has been hosting a competition called the Yelp Dataset Challenge. Thus far, Yelp has offered 8 rounds of this competition to the general public. Since its inception, the Yelp Dataset Challenge has given the machine learning and data science communities a useful and thorough dataset in which to apply state of the art ML algorithms and advanced data analysis to. We chose this dataset because it offers highly relevant data that is granular enough to be useful in our analysis, but not too granular as to require computationally complex routines to pre-process the data.

# 2 Initial Discussion

The dataset consists of 2.7M reviews and 649K tips by 687K users for 86K businesses. Furthermore, there are a total of 566K attributes that can be applied to a business. In addition to data that is core to Yelp's business, the dataset also includes associations between the users creating a graph network of approximately 4.2M edges. All of the data is represented in json form stored in text files and takes up about 2.5GB on disk.

The portion of the data we have chosen to focus on are the review data. We are using reviews as a proxy measure of Yelp's popularity overtime. We are able to do this because each review contains a date in 'yyyy-mm-dd' format which enables us to measure popularity down to the granularity of a day. Because yelp has been in business since 2014, grouping reviews by day gives us TODO: Figure out how many samples we would have samples to build our predictive model with; however, to improve the accuracy of our predictions, we have decided to limit the granularity of time to a month.

## Loading required package: nlme

## This is mgcv 1.8-16. For overview type 'help("mgcv-package")'.

library(ggplot2)  
library(xts)

## Loading required package: zoo

##   
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':  
##   
## as.Date, as.Date.numeric

library(reshape2)  
library(tables)

## Loading required package: Hmisc

## Loading required package: lattice

## Loading required package: survival

## Loading required package: Formula

##   
## Attaching package: 'Hmisc'

## The following object is masked from 'package:plotly':  
##   
## subplot

## The following objects are masked from 'package:base':  
##   
## format.pval, round.POSIXt, trunc.POSIXt, units

library(knitr)  
library(zoo)  
  
# Downloads the 'bc2.R' file.  
download.file("https://raw.githubusercontent.com/brent-halen/TSProject2016/master/bc2.R", destfile = "bc2.R", method = "libcurl")  
source("bc2.R")  
# Downloads 'decom1.R'  
download.file("https://raw.githubusercontent.com/brent-halen/TSProject2016/master/decom1.R",destfile="decom1.R", method="libcurl")  
source("decom1.R")  
# Downloads the 'bulkfit.R' file.  
download.file("https://raw.githubusercontent.com/brent-halen/TSProject2016/master/bulkfit.R",destfile="bulkfit.R",method="libcurl")  
source("bulkfit.R")  
  
# The following is an upgraded version of 'Bulkfit' designed to test seasonal ARIMA models as well as stationary.   
# ###WARNING###   
# This modification will cause the function to test 729 models instead of just 27. It may take a while to complete.  
bulkfit2 <- function(x,y) {  
 w <- matrix(0,nrow=729,ncol=7)  
 ii <- 0  
   
 for(i in 0:2) {  
 for(k in 0:2) {  
 for(j in 0:2) {  
 for(I in 0:2){  
 for(K in 0:2){  
 for(J in 0:2){  
 ii <- ii + 1  
 fit <- try(arima(x,order=c(i,k,j),seasonal= list(order=c(I,K,J),period=y)))  
   
 if(inherits(fit,"try-error")) {  
 w[ii,7] <- 99999   
 }  
 else {  
 w[ii,7] <- fit$aic  
 w[ii,1] <- i  
 w[ii,2] <- k   
 w[ii,3] <- j  
 w[ii,4] <- I  
 w[ii,5] <- K  
 w[ii,6] <- J  
 }  
 }  
 }  
   
 }  
 }  
 }  
 }  
   
 dimnames(w) <- list(NULL,c("ar","d","ma","seasar","seasd","seasma","AIC"))  
 xxx <- which(w[,7]==min(w[,7],na.rm=TRUE))[1]  
 return(list(res=w,min=w[xxx,]))  
   
}  
  
  
  
library(forecast)

## Loading required package: timeDate

## This is forecast 7.3

##   
## Attaching package: 'forecast'

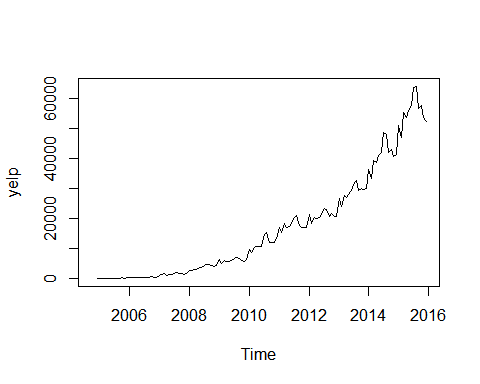
## The following object is masked from 'package:nlme':  
##   
## getResponse

library(MASS)

##   
## Attaching package: 'MASS'

## The following object is masked from 'package:plotly':  
##   
## select

library(quadprog)  
  
# Downloads the final file from the web site.  
link <- "https://raw.githubusercontent.com/brent-halen/TSProject2016/master/reviews.csv"  
reviews <- "reviews.csv"  
download.file(link, destfile = reviews, method = "libcurl")  
  
#yelp = read.zoo(file = reviews, sep = "," , FUN = as.yearmon)  
  
yelp <- read.csv(file = reviews, header = TRUE)  
yelp <- as.data.frame(yelp)  
yelp\_forzoo <- yelp  
yelp\_forzoo$reviewDate <- as.yearmon(yelp\_forzoo$reviewDate)  
yelp <- zoo(yelp\_forzoo$reviews,yelp\_forzoo$reviewDate)  
plot.ts(yelp)

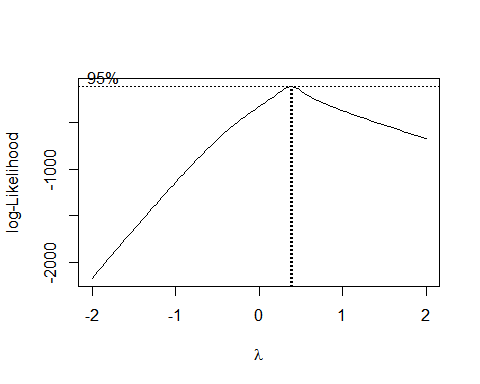


yelp.ts <- as.ts(yelp)

# 3 Model Building

First, we ran the 'bc2' function on the original data.

bc2(yelp.ts,ploty=TRUE)



## [1] 0.3838384

#bc2(yelp.zoo,ploty=TRUE)  
#0.3838384

This returns a value of 0.3838384, so we're goign to raise it to 383/1000.

#yelp.tr1 <- yelp  
#yelp.tr1$reviews = yelp.tr1$reviews^(383/1000)  
  
yelp.tr = yelp.ts^(383/1000)

## Non-Seasonal ARIMA

### Bulkfit

First, we're going to use bulkfit to find a non-seasonal ARIMA model.

yelp.bulkfit <- bulkfit(yelp.tr)  
  
# 1.0000 2.0000 2.0000 516.3467

yelp.bulkfit

## $res  
## ar d ma AIC  
## [1,] 0 0 0 1180.7103  
## [2,] 0 0 1 1027.3342  
## [3,] 0 0 2 897.8681  
## [4,] 0 1 0 539.0409  
## [5,] 0 1 1 535.4975  
## [6,] 0 1 2 535.9028  
## [7,] 0 2 0 652.6826  
## [8,] 0 2 1 532.7091  
## [9,] 0 2 2 520.9066  
## [10,] 1 0 0 552.5392  
## [11,] 1 0 1 549.0796  
## [12,] 1 0 2 549.4349  
## [13,] 1 1 0 534.5251  
## [14,] 1 1 1 536.1724  
## [15,] 1 1 2 537.6569  
## [16,] 1 2 0 586.4044  
## [17,] 1 2 1 522.3971  
## [18,] 1 2 2 516.3467  
## [19,] 2 0 0 548.1023  
## [20,] 2 0 1 549.8817  
## [21,] 2 0 2 548.5923  
## [22,] 2 1 0 535.9705  
## [23,] 2 1 1 537.9192  
## [24,] 2 1 2 534.7806  
## [25,] 2 2 0 568.8199  
## [26,] 2 2 1 524.0569  
## [27,] 2 2 2 525.7721  
##   
## $min  
## ar d ma AIC   
## 1.0000 2.0000 2.0000 516.3467

### Deriving the model

yelp.tr.fit <- arima(yelp.tr,order =c(1,2,2))  
  
yelp.tr.fit

##   
## Call:  
## arima(x = yelp.tr, order = c(1, 2, 2))  
##   
## Coefficients:  
## ar1 ma1 ma2  
## 0.5384 -1.9144 0.9144  
## s.e. 0.1318 0.1004 0.0993  
##   
## sigma^2 estimated as 2.596: log likelihood = -254.17, aic = 516.35

#Coefficients:  
# ar1 ma1 ma2  
# 0.5384 -1.9144 0.9144  
#s.e. 0.1318 0.1004 0.0993  
  
#sigma^2 estimated as 2.596: log likelihood = -254.17, aic = 516.35

The most accurate seasonal ARIMA model (the (1,2,2) one) has an aic of 516.35, so we're going to model that one. The equation yields:

### Making Predictions

yelp.tr.pred = predict(yelp.tr.fit, n.ahead=6)  
  
length(yelp)

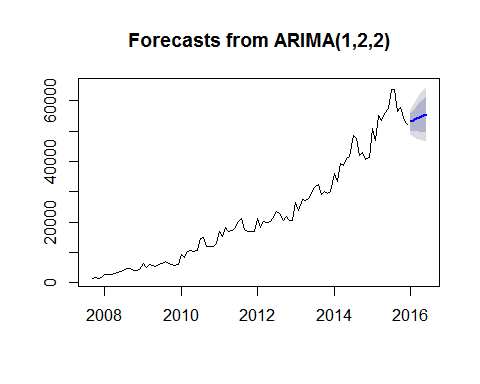
## [1] 134

#134  
  
Lower = yelp.tr.pred$pred - 1.96\*yelp.tr.pred$se/sqrt(134)  
Upper = yelp.tr.pred$pred + 1.96\*yelp.tr.pred$se/sqrt(134)  
Predict = yelp.tr.pred$pred  
pred.mat = cbind(Lower,Predict,Upper)  
final.mat = pred.mat^(1000/383)  
kable(final.mat)

|  |  |  |
| --- | --- | --- |
| Lower | Predict | Upper |
| 55748.98 | 56357.62 | 56970.34 |
| 58410.38 | 59151.87 | 59899.13 |
| 60420.78 | 61227.58 | 62040.99 |
| 62061.33 | 62909.14 | 63764.06 |
| 63501.07 | 64379.64 | 65265.68 |
| 64836.08 | 65740.74 | 66653.16 |

### Plotting our ARIMA model

fit\_ar = arima(yelp, order= c(1,2,2))  
fit\_ar\_f = forecast(fit\_ar, h =6)  
plot(fit\_ar\_f, include =100)



## Seasonal ARIMA

yelp.bulkfit2 <- bulkfit2(yelp.tr,12)  
# 0.0000 1.0000 2.0000 0.0000 1.0000 2.0000 361.69

yelp.bulkfit2

## $res  
## ar d ma seasar seasd seasma AIC  
## [1,] 0 0 0 0 0 0 1180.7103  
## [2,] 0 0 0 0 0 1 1061.4714  
## [3,] 0 0 0 0 0 2 976.3585  
## [4,] 0 0 0 0 1 0 801.9980  
## [5,] 0 0 0 0 1 1 724.8381  
## [6,] 0 0 0 0 1 2 699.7711  
## [7,] 0 0 0 0 2 0 563.3015  
## [8,] 0 0 0 0 2 1 498.9323  
## [9,] 0 0 0 0 2 2 491.3265  
## [10,] 0 0 0 1 0 0 884.6853  
## [11,] 0 0 0 1 0 1 844.1874  
## [12,] 0 0 0 1 0 2 818.6238  
## [13,] 0 0 0 1 1 0 637.3793  
## [14,] 0 0 0 1 1 1 578.5664  
## [15,] 0 0 0 1 1 2 570.7098  
## [16,] 0 0 0 1 2 0 541.1520  
## [17,] 0 0 0 1 2 1 497.8788  
## [18,] 0 0 0 1 2 2 486.9710  
## [19,] 0 0 0 2 0 0 756.6216  
## [20,] 0 0 0 2 0 1 717.0953  
## [21,] 0 0 0 2 0 2 736.1565  
## [22,] 0 0 0 2 1 0 619.8850  
## [23,] 0 0 0 2 1 1 577.5192  
## [24,] 0 0 0 2 1 2 582.2472  
## [25,] 0 0 0 2 2 0 508.3003  
## [26,] 0 0 0 2 2 1 485.0864  
## [27,] 0 0 0 2 2 2 484.2916  
## [28,] 0 0 1 0 0 0 1027.3342  
## [29,] 0 0 1 0 0 1 909.6698  
## [30,] 0 0 1 0 0 2 832.9989  
## [31,] 0 0 1 0 1 0 661.4039  
## [32,] 0 0 1 0 1 1 614.0222  
## [33,] 0 0 1 0 1 2 592.3102  
## [34,] 0 0 1 0 2 0 500.4780  
## [35,] 0 0 1 0 2 1 431.5353  
## [36,] 0 0 1 0 2 2 418.2850  
## [37,] 0 0 1 1 0 0 763.8240  
## [38,] 0 0 1 1 0 1 717.0785  
## [39,] 0 0 1 1 0 2 695.2531  
## [40,] 0 0 1 1 1 0 559.1980  
## [41,] 0 0 1 1 1 1 498.1206  
## [42,] 0 0 1 1 1 2 484.2609  
## [43,] 0 0 1 1 2 0 464.0071  
## [44,] 0 0 1 1 2 1 424.5516  
## [45,] 0 0 1 1 2 2 418.2268  
## [46,] 0 0 1 2 0 0 617.5808  
## [47,] 0 0 1 2 0 1 695.2276  
## [48,] 0 0 1 2 0 2 601.2510  
## [49,] 0 0 1 2 1 0 528.4145  
## [50,] 0 0 1 2 1 1 490.4954  
## [51,] 0 0 1 2 1 2 500.5757  
## [52,] 0 0 1 2 2 0 441.4340  
## [53,] 0 0 1 2 2 1 420.6832  
## [54,] 0 0 1 2 2 2 420.0049  
## [55,] 0 0 2 0 0 0 897.8681  
## [56,] 0 0 2 0 0 1 815.8143  
## [57,] 0 0 2 0 0 2 744.5894  
## [58,] 0 0 2 0 1 0 587.1632  
## [59,] 0 0 2 0 1 1 573.7799  
## [60,] 0 0 2 0 1 2 551.6963  
## [61,] 0 0 2 0 2 0 489.3168  
## [62,] 0 0 2 0 2 1 422.6848  
## [63,] 0 0 2 0 2 2 406.7264  
## [64,] 0 0 2 1 0 0 679.5363  
## [65,] 0 0 2 1 0 1 666.8415  
## [66,] 0 0 2 1 0 2 645.8707  
## [67,] 0 0 2 1 1 0 547.1646  
## [68,] 0 0 2 1 1 1 477.2210  
## [69,] 0 0 2 1 1 2 456.6713  
## [70,] 0 0 2 1 2 0 450.5798  
## [71,] 0 0 2 1 2 1 412.1856  
## [72,] 0 0 2 1 2 2 407.7479  
## [73,] 0 0 2 2 0 0 648.4428  
## [74,] 0 0 2 2 0 1 644.7450  
## [75,] 0 0 2 2 0 2 648.7489  
## [76,] 0 0 2 2 1 0 497.0170  
## [77,] 0 0 2 2 1 1 461.4712  
## [78,] 0 0 2 2 1 2 458.5029  
## [79,] 0 0 2 2 2 0 430.8864  
## [80,] 0 0 2 2 2 1 410.4188  
## [81,] 0 0 2 2 2 2 409.7397  
## [82,] 0 1 0 0 0 0 539.0409  
## [83,] 0 1 0 0 0 1 489.0234  
## [84,] 0 1 0 0 0 2 459.8263  
## [85,] 0 1 0 0 1 0 395.1903  
## [86,] 0 1 0 0 1 1 365.0790  
## [87,] 0 1 0 0 1 2 365.0755  
## [88,] 0 1 0 0 2 0 473.9433  
## [89,] 0 1 0 0 2 1 401.7020  
## [90,] 0 1 0 0 2 2 378.4710  
## [91,] 0 1 0 1 0 0 433.4733  
## [92,] 0 1 0 1 0 1 411.6455  
## [93,] 0 1 0 1 0 2 411.9453  
## [94,] 0 1 0 1 1 0 367.7860  
## [95,] 0 1 0 1 1 1 365.3508  
## [96,] 0 1 0 1 1 2 366.8347  
## [97,] 0 1 0 1 2 0 415.2842  
## [98,] 0 1 0 1 2 1 382.3693  
## [99,] 0 1 0 1 2 2 380.3589  
## [100,] 0 1 0 2 0 0 413.3276  
## [101,] 0 1 0 2 0 1 411.8971  
## [102,] 0 1 0 2 0 2 413.6398  
## [103,] 0 1 0 2 1 0 366.5822  
## [104,] 0 1 0 2 1 1 367.3034  
## [105,] 0 1 0 2 1 2 368.8016  
## [106,] 0 1 0 2 2 0 401.2712  
## [107,] 0 1 0 2 2 1 382.8206  
## [108,] 0 1 0 2 2 2 384.5923  
## [109,] 0 1 1 0 0 0 535.4975  
## [110,] 0 1 1 0 0 1 483.0260  
## [111,] 0 1 1 0 0 2 457.3233  
## [112,] 0 1 1 0 1 0 391.1161  
## [113,] 0 1 1 0 1 1 364.8660  
## [114,] 0 1 1 0 1 2 365.5913  
## [115,] 0 1 1 0 2 0 466.8968  
## [116,] 0 1 1 0 2 1 397.4388  
## [117,] 0 1 1 0 2 2 377.9639  
## [118,] 0 1 1 1 0 0 429.0558  
## [119,] 0 1 1 1 0 1 410.6234  
## [120,] 0 1 1 1 0 2 411.4532  
## [121,] 0 1 1 1 1 0 368.9083  
## [122,] 0 1 1 1 1 1 365.8967  
## [123,] 0 1 1 1 1 2 367.1528  
## [124,] 0 1 1 1 2 0 416.1451  
## [125,] 0 1 1 1 2 1 382.6185  
## [126,] 0 1 1 1 2 2 379.9570  
## [127,] 0 1 1 2 0 0 413.5214  
## [128,] 0 1 1 2 0 1 411.6515  
## [129,] 0 1 1 2 0 2 413.6581  
## [130,] 0 1 1 2 1 0 366.7212  
## [131,] 0 1 1 2 1 1 367.6124  
## [132,] 0 1 1 2 1 2 368.8055  
## [133,] 0 1 1 2 2 0 399.7381  
## [134,] 0 1 1 2 2 1 381.9441  
## [135,] 0 1 1 2 2 2 383.6814  
## [136,] 0 1 2 0 0 0 535.9028  
## [137,] 0 1 2 0 0 1 484.5757  
## [138,] 0 1 2 0 0 2 459.3190  
## [139,] 0 1 2 0 1 0 389.9638  
## [140,] 0 1 2 0 1 1 362.0848  
## [141,] 0 1 2 0 1 2 361.6938  
## [142,] 0 1 2 0 2 0 468.5171  
## [143,] 0 1 2 0 2 1 396.7331  
## [144,] 0 1 2 0 2 2 373.4564  
## [145,] 0 1 2 1 0 0 429.7542  
## [146,] 0 1 2 1 0 1 409.5134  
## [147,] 0 1 2 1 0 2 409.3344  
## [148,] 0 1 2 1 1 0 364.2408  
## [149,] 0 1 2 1 1 1 362.3271  
## [150,] 0 1 2 1 1 2 363.1274  
## [151,] 0 1 2 1 2 0 413.1790  
## [152,] 0 1 2 1 2 1 377.5227  
## [153,] 0 1 2 1 2 2 375.1714  
## [154,] 0 1 2 2 0 0 411.3204  
## [155,] 0 1 2 2 0 1 409.9570  
## [156,] 0 1 2 2 0 2 412.1760  
## [157,] 0 1 2 2 1 0 362.6095  
## [158,] 0 1 2 2 1 1 364.0250  
## [159,] 0 1 2 2 1 2 365.0325  
## [160,] 0 1 2 2 2 0 394.4552  
## [161,] 0 1 2 2 2 1 376.8747  
## [162,] 0 1 2 2 2 2 378.6007  
## [163,] 0 2 0 0 0 0 652.6826  
## [164,] 0 2 0 0 0 1 605.5166  
## [165,] 0 2 0 0 0 2 568.0829  
## [166,] 0 2 0 0 1 0 500.8294  
## [167,] 0 2 0 0 1 1 463.1330  
## [168,] 0 2 0 0 1 2 460.2606  
## [169,] 0 2 0 0 2 0 564.1490  
## [170,] 0 2 0 0 2 1 487.5142  
## [171,] 0 2 0 0 2 2 456.1603  
## [172,] 0 2 0 1 0 0 544.0467  
## [173,] 0 2 0 1 0 1 514.3013  
## [174,] 0 2 0 1 0 2 512.8926  
## [175,] 0 2 0 1 1 0 459.6266  
## [176,] 0 2 0 1 1 1 459.4756  
## [177,] 0 2 0 1 1 2 460.3412  
## [178,] 0 2 0 1 2 0 488.6710  
## [179,] 0 2 0 1 2 1 457.0710  
## [180,] 0 2 0 1 2 2 457.0836  
## [181,] 0 2 0 2 0 0 510.5545  
## [182,] 0 2 0 2 0 1 510.8114  
## [183,] 0 2 0 2 0 2 511.6743  
## [184,] 0 2 0 2 1 0 460.4646  
## [185,] 0 2 0 2 1 1 461.2351  
## [186,] 0 2 0 2 1 2 462.3299  
## [187,] 0 2 0 2 2 0 476.9703  
## [188,] 0 2 0 2 2 1 458.7244  
## [189,] 0 2 0 2 2 2 459.4919  
## [190,] 0 2 1 0 0 0 532.7091  
## [191,] 0 2 1 0 0 1 485.1206  
## [192,] 0 2 1 0 0 2 457.5572  
## [193,] 0 2 1 0 1 0 405.4762  
## [194,] 0 2 1 0 1 1 376.9939  
## [195,] 0 2 1 0 1 2 376.7886  
## [196,] 0 2 1 0 2 0 472.4710  
## [197,] 0 2 1 0 2 1 403.3717  
## [198,] 0 2 1 0 2 2 384.5865  
## [199,] 0 2 1 1 0 0 432.7160  
## [200,] 0 2 1 1 0 1 411.0047  
## [201,] 0 2 1 1 0 2 410.8959  
## [202,] 0 2 1 1 1 0 379.0379  
## [203,] 0 2 1 1 1 1 377.1363  
## [204,] 0 2 1 1 1 2 378.4351  
## [205,] 0 2 1 1 2 0 415.4226  
## [206,] 0 2 1 1 2 1 384.9000  
## [207,] 0 2 1 1 2 2 382.9567  
## [208,] 0 2 1 2 0 0 412.7405  
## [209,] 0 2 1 2 0 1 411.2741  
## [210,] 0 2 1 2 0 2 413.0091  
## [211,] 0 2 1 2 1 0 378.1352  
## [212,] 0 2 1 2 1 1 379.0790  
## [213,] 0 2 1 2 1 2 380.3909  
## [214,] 0 2 1 2 2 0 402.1788  
## [215,] 0 2 1 2 2 1 385.4816  
## [216,] 0 2 1 2 2 2 386.6133  
## [217,] 0 2 2 0 0 0 520.9066  
## [218,] 0 2 2 0 0 1 472.6365  
## [219,] 0 2 2 0 0 2 452.1202  
## [220,] 0 2 2 0 1 0 402.0539  
## [221,] 0 2 2 0 1 1 377.0939  
## [222,] 0 2 2 0 1 2 377.6002  
## [223,] 0 2 2 0 2 0 466.2089  
## [224,] 0 2 2 0 2 1 399.8059  
## [225,] 0 2 2 0 2 2 380.9928  
## [226,] 0 2 2 1 0 0 427.2466  
## [227,] 0 2 2 1 0 1 409.7602  
## [228,] 0 2 2 1 0 2 410.4618  
## [229,] 0 2 2 1 1 0 380.3715  
## [230,] 0 2 2 1 1 1 377.9738  
## [231,] 0 2 2 1 1 2 379.0517  
## [232,] 0 2 2 1 2 0 416.5473  
## [233,] 0 2 2 1 2 1 385.5084  
## [234,] 0 2 2 1 2 2 382.9861  
## [235,] 0 2 2 2 0 0 412.7420  
## [236,] 0 2 2 2 0 1 410.8487  
## [237,] 0 2 2 2 0 2 412.8613  
## [238,] 0 2 2 2 1 0 378.6360  
## [239,] 0 2 2 2 1 1 379.7059  
## [240,] 0 2 2 2 1 2 380.7158  
## [241,] 0 2 2 2 2 0 401.2901  
## [242,] 0 2 2 2 2 1 385.1441  
## [243,] 0 2 2 2 2 2 386.6225  
## [244,] 1 0 0 0 0 0 552.5392  
## [245,] 1 0 0 0 0 1 502.5453  
## [246,] 1 0 0 0 0 2 473.2701  
## [247,] 1 0 0 0 1 0 402.2767  
## [248,] 1 0 0 0 1 1 373.1938  
## [249,] 1 0 0 0 1 2 373.4374  
## [250,] 1 0 0 0 2 0 460.0599  
## [251,] 1 0 0 0 2 1 388.0919  
## [252,] 1 0 0 0 2 2 367.4834  
## [253,] 1 0 0 1 0 0 447.0075  
## [254,] 1 0 0 1 0 1 444.6432  
## [255,] 1 0 0 1 0 2 426.4011  
## [256,] 1 0 0 1 1 0 375.6034  
## [257,] 1 0 0 1 1 1 373.4051  
## [258,] 1 0 0 1 1 2 377.8107  
## [259,] 1 0 0 1 2 0 405.5589  
## [260,] 1 0 0 1 2 1 371.7435  
## [261,] 1 0 0 1 2 2 369.4834  
## [262,] 1 0 0 2 0 0 427.6031  
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## [715,] 2 2 2 1 1 0 377.7820  
## [716,] 2 2 2 1 1 1 376.6481  
## [717,] 2 2 2 1 1 2 377.1771  
## [718,] 2 2 2 1 2 0 414.5443  
## [719,] 2 2 2 1 2 1 382.2757  
## [720,] 2 2 2 1 2 2 379.9686  
## [721,] 2 2 2 2 0 0 412.2263  
## [722,] 2 2 2 2 0 1 410.8903  
## [723,] 0 0 0 0 0 0 99999.0000  
## [724,] 2 2 2 2 1 0 376.8468  
## [725,] 2 2 2 2 1 1 378.4161  
## [726,] 2 2 2 2 1 2 379.1335  
## [727,] 2 2 2 2 2 0 396.4223  
## [728,] 2 2 2 2 2 1 381.7273  
## [729,] 2 2 2 2 2 2 382.9037  
##   
## $min  
## ar d ma seasar seasd seasma AIC   
## 0.0000 1.0000 2.0000 0.0000 1.0000 2.0000 361.6938

yelp.tr.fit2 <- arima(yelp.tr, order = c(0,1,2),seasonal = list(order=c(0,1,2),period=12))  
  
  
yelp.tr.fit2

##   
## Call:  
## arima(x = yelp.tr, order = c(0, 1, 2), seasonal = list(order = c(0, 1, 2), period = 12))  
##   
## Coefficients:  
## ma1 ma2 sma1 sma2  
## -0.1155 -0.2259 -0.6475 0.1870  
## s.e. 0.0907 0.0884 0.1093 0.1181  
##   
## sigma^2 estimated as 1.021: log likelihood = -175.85, aic = 361.69

# Call:  
# arima(x = yelp.tr, order = c(0, 1, 2), seasonal = list(order = c(0, 1, 2), period = 12))  
#   
# Coefficients:  
# ma1 ma2 sma1 sma2  
# -0.1155 -0.2259 -0.6475 0.1870  
# s.e. 0.0907 0.0884 0.1093 0.1181  
#   
# sigma^2 estimated as 1.021: log likelihood = -175.85, aic = 361.69

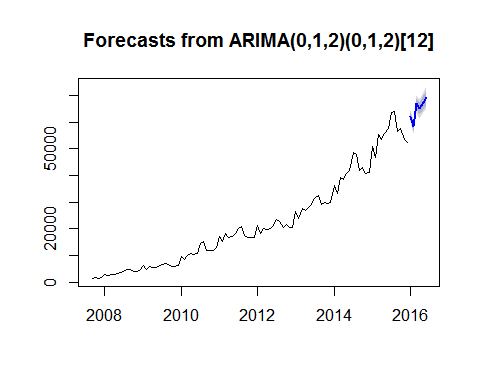
The most accurate seasonal ARIMA model (the (0,1,2)(0,1,2)[12] one) has an aic of 361.69, so we're going to model that one. The equation yields:

yelp.tr.pred2 = predict(yelp.tr.fit2, n.ahead=6)  
Lower2 = yelp.tr.pred2$pred - 1.96\*yelp.tr.pred2$se/sqrt(134)  
Upper2 = yelp.tr.pred2$pred + 1.96\*yelp.tr.pred2$se/sqrt(134)  
Predict2 = yelp.tr.pred2$pred  
pred2.mat = cbind(Lower2,Predict2,Upper2)  
final2.mat = pred2.mat^(1000/383)  
kable(final2.mat)

|  |  |  |
| --- | --- | --- |
| Lower2 | Predict2 | Upper2 |
| 62598.15 | 63005.87 | 63415.23 |
| 58578.62 | 59101.50 | 59627.25 |
| 66681.60 | 67313.26 | 67948.60 |
| 65336.05 | 66018.34 | 66705.00 |
| 67881.30 | 68635.02 | 69393.88 |
| 69576.52 | 70394.01 | 71217.41 |

### Plotting

fit\_ar2 = arima(yelp, order = c(0,1,2),seasonal = list(order=c(0,1,2),period=12))  
  
  
fit\_ar\_f2 = forecast(fit\_ar2,h=6)  
  
  
plot(fit\_ar\_f2,include=100)



######decom   
yelp.dec = decom1(yelp,fore1 =12,se1 =12)

## (Intercept) t1   
## -11673.7925 421.1653   
## pred lower upper  
## 1 45183.52 31814.18 58552.87  
## 2 45604.69 32230.94 58978.43  
## 3 46025.85 32647.65 59404.06  
## 4 46447.02 33064.28 59829.76  
## 5 46868.19 33480.86 60255.51  
## 6 47289.35 33897.37 60681.33  
## 7 47710.52 34313.82 61107.21  
## 8 48131.68 34730.21 61533.16  
## 9 48552.85 35146.53 61959.16  
## 10 48974.01 35562.79 62385.23  
## 11 49395.18 35978.99 62811.37  
## 12 49816.34 36395.12 63237.56

yelp.dec.final = yelp.dec$pred.df  
  
kable(yelp.dec.final)

|  |  |  |
| --- | --- | --- |
| pred | lower | upper |
| 45183.52 | 31814.18 | 58552.87 |
| 45604.69 | 32230.94 | 58978.43 |
| 46025.85 | 32647.65 | 59404.06 |
| 46447.02 | 33064.28 | 59829.76 |
| 46868.19 | 33480.86 | 60255.51 |
| 47289.35 | 33897.37 | 60681.33 |
| 47710.52 | 34313.82 | 61107.21 |
| 48131.68 | 34730.21 | 61533.16 |
| 48552.85 | 35146.53 | 61959.16 |
| 48974.01 | 35562.79 | 62385.23 |
| 49395.18 | 35978.99 | 62811.37 |
| 49816.34 | 36395.12 | 63237.56 |

#######using forecast to make plot