ENSEMBLES OF ARIMA AND ARIMAX MODELS FOR FLU FORECASTING

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LOADING LIBRARIES

```
library("tidyr")
library("MMWRweek")
library("data.table")
library("caret")
```

```
## Loading required package: ggplot2
```

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

```
library("purrr")
```

```
##
## Attaching package: 'purrr'
```

```
## The following object is masked from 'package:caret':
##
##     lift
```

```
## The following object is masked from 'package:data.table':
##
##     transpose
```

```
library("dplyr")
```

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

```
## The following objects are masked from 'package:data.table':
##
##     between, first, last
```

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

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

```
library("tseries")
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
library("gtools")
library("forecast")
library("scoringutils")
```

```
## Note: scoringutils is currently undergoing major development changes (with an update planned for the
```

```
library("covidHubUtils")
library("parallel")
library("future")#https://cran.r-project.org/web/packages/future/vignettes/future-4-issues.html
```

```
##
## Attaching package: 'future'
```

```
## The following object is masked from 'package:tseries':
##
##     value
```

```
## The following object is masked from 'package:caret':
##
##     cluster
```

```
library("listenv")
```

```
##
## Attaching package: 'listenv'
```

```
## The following object is masked from 'package:purrr':
##
##     map
```

```
library("epitools")
library("ggplot2")
library("sf")
```

```
## Linking to GEOS 3.11.0, GDAL 3.5.3, PROJ 9.1.0; sf_use_s2() is TRUE
```

```
library("forcats")
```

LOADING DATA

```r
load("ARIMA_MODELS_correct.Rdata")
load("ADJACENT_MODELS_correct.Rdata")
load("TEMPERATURE_MODELS_correct.Rdata")
load("EPIWEEK_MODELS_correct.Rdata")
```

*SAVE AS FUNCTIONS LATER

```r
calculate_mean_wis <- function(state_list) {
  # Capture the name of the input list
  list_name <- deparse(substitute(state_list))

  # Get the number of states in the list
  num_states <- length(state_list)

  # Initialize vectors to store state names and mean values
  state_names <- vector("character", length = num_states)
  mean_values <- vector("numeric", length = num_states)

  # Iterate through the states
  for (state in 1:num_states) {
    # Get the name of the state
    state_name <- names(state_list)[state]

    # Get the mean WIS value for the state
    mean_wis <- mean(state_list[[state]]$WIS, na.rm = TRUE)  # Use na.rm = TRUE to handle NA values

    # Store the state name and mean value in the vectors
    state_names[state] <- state_name
    mean_values[state] <- mean_wis
  }

  # Create a data frame with a dynamic column name
  results_df <- data.frame(State = state_names)
  results_df[[list_name]] <- mean_values

  # Return the data frame
  return(results_df)
}
```

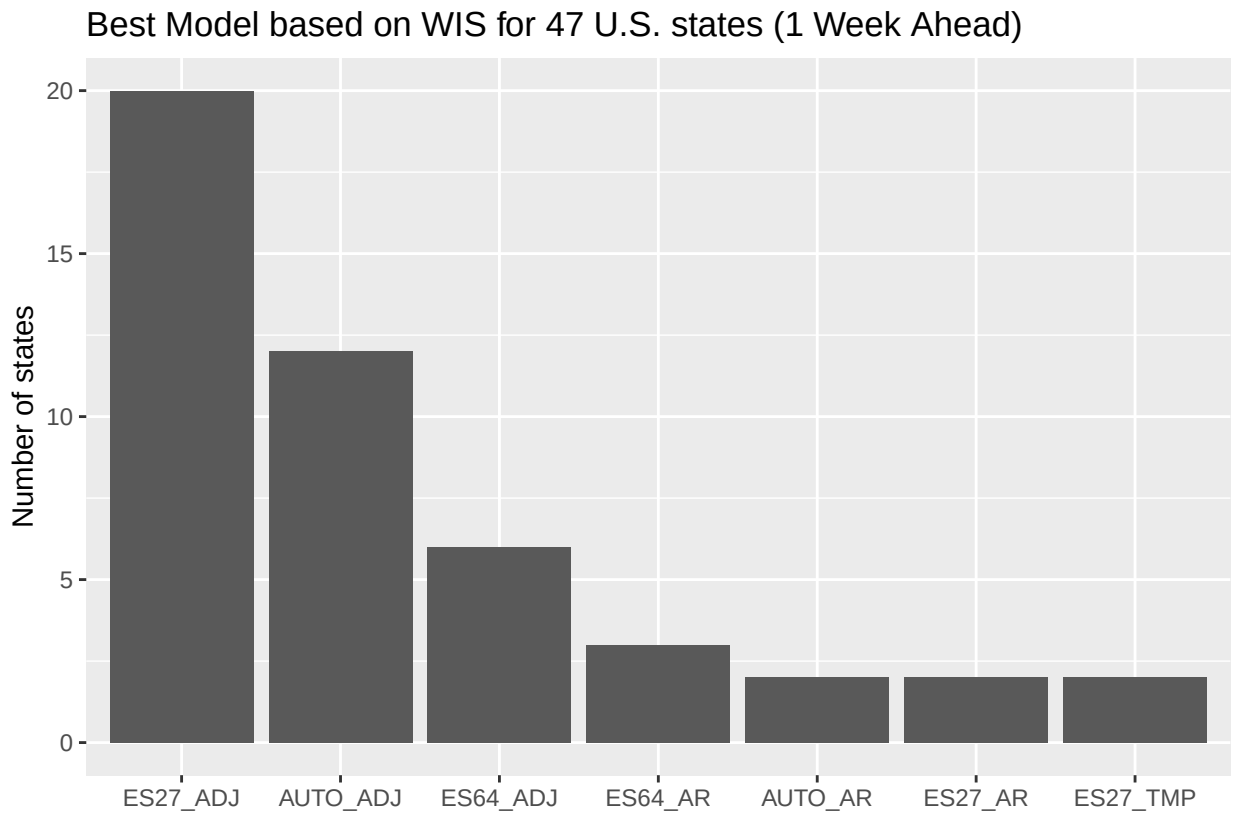
COMPARING WIS RESULTS FOR 1-4 WEEKS AHEAD

```r
W1<-NULL

# AUTO ARIMA RESULTS
AUTO_AR_W1 <- calculate_mean_wis(AUTO_ARIMA_WEEK1_list)
ES27_AR_W1 <- calculate_mean_wis(ES27_ARIMA_WEEK1_list)
ES64_AR_W1 <- calculate_mean_wis(ES64_ARIMA_WEEK1_list)
# ADJACENT ARIMAX RESULTS
AUTO_ADJ_W1 <- calculate_mean_wis(AUTO_ADJACENT_WEEK1_list)
ES27_ADJ_W1 <- calculate_mean_wis(ES27_ADJACENT_WEEK1_list)
ES64_ADJ_W1 <- calculate_mean_wis(ES64_ADJACENT_WEEK1_list)
# TEMPERATURE ARIMAX RESULTS
AUTO_TMP_W1 <- calculate_mean_wis(AUTO_TEMPERATURE_WEEK1_list)
```

```r
ES27_TMP_W1 <- calculate_mean_wis(ES27_TEMPERATURE_WEEK1_list)
ES64_TMP_W1 <- calculate_mean_wis(ES64_TEMPERATURE_WEEK1_list)
# EPIWEEK ARIMAX RESULTS
AUTO_EPI_W1 <- calculate_mean_wis(AUTO_EPIWEEK_WEEK1_list)
ES27_EPI_W1 <- calculate_mean_wis(ES27_EPIWEEK_WEEK1_list)
ES64_EPI_W1 <- calculate_mean_wis(ES64_EPIWEEK_WEEK1_list)

# AUTO ARIMA RESULTS
W1 <- merge(AUTO_AR_W1, ES27_AR_W1, by = "State")
W1 <- merge(W1, ES64_AR_W1, by = "State")
# ADJACENT ARIMAX RESULTS
W1 <- merge(W1, AUTO_ADJ_W1, by = "State")
W1 <- merge(W1, ES27_ADJ_W1, by = "State")
W1 <- merge(W1, ES64_ADJ_W1, by = "State")
# TEMPERATURE ARIMAX RESULTS
W1 <- merge(W1, AUTO_TMP_W1, by = "State")
W1 <- merge(W1, ES27_TMP_W1, by = "State")
W1 <- merge(W1, ES64_TMP_W1, by = "State")
# EPIWEEK ARIMAX RESULTS
W1 <- merge(W1, AUTO_EPI_W1, by = "State")
W1 <- merge(W1, ES27_EPI_W1, by = "State")
W1 <- merge(W1, ES64_EPI_W1, by = "State")

# Rename columns for clarity
colnames(W1)[1] <- "NAME"
colnames(W1)[2] <- "AUTO_AR"
colnames(W1)[3] <- "ES27_AR"
colnames(W1)[4] <- "ES64_AR"
colnames(W1)[5] <- "AUTO_ADJ"
colnames(W1)[6] <- "ES27_ADJ"
colnames(W1)[7] <- "ES64_ADJ"
colnames(W1)[8] <- "AUTO_TMP"
colnames(W1)[9] <- "ES27_TMP"
colnames(W1)[10] <- "ES64_TMP"
colnames(W1)[11] <- "AUTO_EPI"
colnames(W1)[12] <- "ES27_EPI"
colnames(W1)[13] <- "ES64_EPI"

# Identify the best result for each state
#W1$Best_Result <- apply(W1[,2:13], 1, function(x) {
#  which.min(x)
#})

W1$Best_Result <- apply(W1[, 2:13], 1, function(x) {
  colnames(W1)[which.min(x) + 1]  # +1 to shift the index to account for column 1
})

# REORDER BY FREQUENCY
W1$Best_Result <- fct_infreq(W1$Best_Result)


# Print merged results
head(W1)
```

```
##          NAME   AUTO_AR   ES27_AR   ES64_AR  AUTO_ADJ  ES27_ADJ  ES64_ADJ
## 1     Alabama 103.52566 104.22019 105.13084 101.45966 100.16864 109.01477
## 2     Arizona  46.36650  46.54965  47.65001  45.60075  44.65202  45.93376
## 3    Arkansas  24.39505  23.79665  23.91488  25.13808  24.97169  24.84641
## 4  California 156.69245 155.90429 154.73430 156.10423 152.45771 159.10129
## 5    Colorado  70.02388  69.43872  69.44417  66.94344  66.72838  71.40276
## 6 Connecticut  51.35660  51.02642  52.19473  50.28933  51.06828  54.48616
##    AUTO_TMP  ES27_TMP  ES64_TMP  AUTO_EPI  ES27_EPI  ES64_EPI Best_Result
## 1 104.32674 105.67750 107.36301 109.15158 108.02119 107.24986    ES27_ADJ
## 2  46.79212  46.39031  46.86298  48.55342  47.42529  47.81730    ES27_ADJ
## 3  25.05808  24.27697  24.64173  25.41587  25.32682  25.04705     ES27_AR
## 4 158.70497 157.59665 156.44105 163.92647 160.31558 161.32314    ES27_ADJ
## 5  70.28172  70.23868  70.34410  72.15381  71.43358  71.59568    ES27_ADJ
## 6  52.18867  53.30628  55.10654  53.68471  52.95653  54.84014    AUTO_ADJ
```

```
# --------- WEEK1 MODELS ------------- #
ggplot(W1,aes(x=Best_Result)) + geom_bar()+
  labs(title = "Best Model based on WIS for 47 U.S. states (1 Week Ahead)",
       x = "", y="Number of states") #+ scale_x_discrete()
```



WEEK 2

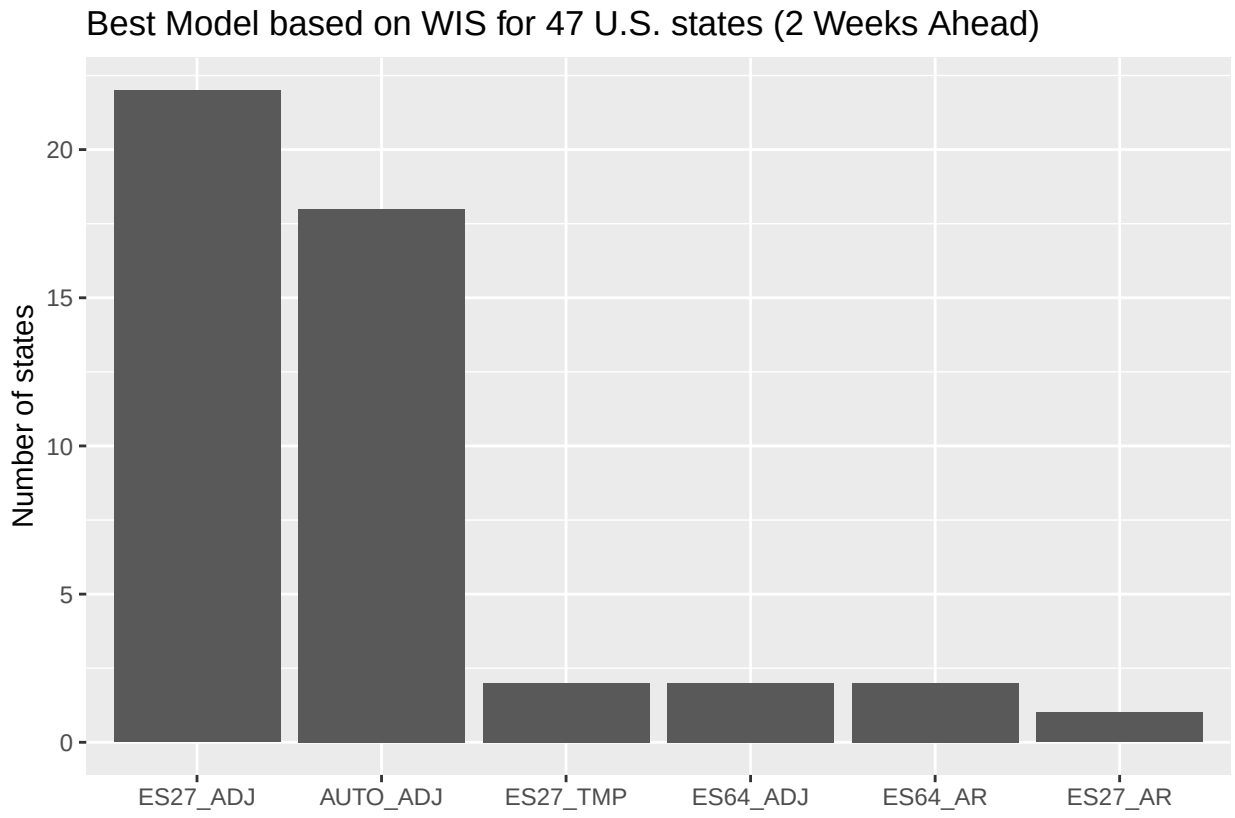
```
W2<-NULL

# AUTO ARIMA RESULTS
AUTO_AR_W2 <- calculate_mean_wis(AUTO_ARIMA_WEEK2_list)
```

```r
ES27_AR_W2 <- calculate_mean_wis(ES27_ARIMA_WEEK2_list)
ES64_AR_W2 <- calculate_mean_wis(ES64_ARIMA_WEEK2_list)
# ADJACENT ARIMAX RESULTS
AUTO_ADJ_W2 <- calculate_mean_wis(AUTO_ADJACENT_WEEK2_list)
ES27_ADJ_W2 <- calculate_mean_wis(ES27_ADJACENT_WEEK2_list)
ES64_ADJ_W2 <- calculate_mean_wis(ES64_ADJACENT_WEEK2_list)
# TEMPERATURE ARIMAX RESULTS
AUTO_TMP_W2 <- calculate_mean_wis(AUTO_TEMPERATURE_WEEK2_list)
ES27_TMP_W2 <- calculate_mean_wis(ES27_TEMPERATURE_WEEK2_list)
ES64_TMP_W2 <- calculate_mean_wis(ES64_TEMPERATURE_WEEK2_list)
# EPIWEEK ARIMAX RESULTS
AUTO_EPI_W2 <- calculate_mean_wis(AUTO_EPIWEEK_WEEK2_list)
ES27_EPI_W2 <- calculate_mean_wis(ES27_EPIWEEK_WEEK2_list)
ES64_EPI_W2 <- calculate_mean_wis(ES64_EPIWEEK_WEEK2_list)

# MERGE
# AUTO ARIMA RESULTS
W2 <- merge(AUTO_AR_W2, ES27_AR_W2, by = "State")
W2 <- merge(W2, ES64_AR_W2, by = "State")
# ADJACENT ARIMAX RESULTS
W2 <- merge(W2, AUTO_ADJ_W2, by = "State")
W2 <- merge(W2, ES27_ADJ_W2, by = "State")
W2 <- merge(W2, ES64_ADJ_W2, by = "State")
# TEMPERATURE ARIMAX RESULTS
W2 <- merge(W2, AUTO_TMP_W2, by = "State")
W2 <- merge(W2, ES27_TMP_W2, by = "State")
W2 <- merge(W2, ES64_TMP_W2, by = "State")
# EPIWEEK ARIMAX RESULTS
W2 <- merge(W2, AUTO_EPI_W2, by = "State")
W2 <- merge(W2, ES27_EPI_W2, by = "State")
W2 <- merge(W2, ES64_EPI_W2, by = "State")

# Rename columns for clarity
colnames(W2)[1] <- "NAME"
colnames(W2)[2] <- "AUTO_AR"
colnames(W2)[3] <- "ES27_AR"
colnames(W2)[4] <- "ES64_AR"
colnames(W2)[5] <- "AUTO_ADJ"
colnames(W2)[6] <- "ES27_ADJ"
colnames(W2)[7] <- "ES64_ADJ"
colnames(W2)[8] <- "AUTO_TMP"
colnames(W2)[9] <- "ES27_TMP"
colnames(W2)[10] <- "ES64_TMP"
colnames(W2)[11] <- "AUTO_EPI"
colnames(W2)[12] <- "ES27_EPI"
colnames(W2)[13] <- "ES64_EPI"

# Identify the best result for each state
#W2$Best_Result <- apply(W2[,2:13], 1, function(x) {
#  which.min(x)
#})

W2$Best_Result <- apply(W2[, 2:13], 1, function(x) {
```

```r
  colnames(W2)[which.min(x) + 1]  # +1 to shift the index to account for column 1
})

# REORDER BY FREQUENCY
W2$Best_Result <- fct_infreq(W2$Best_Result)

# Print merged results
head(W2)
```

```
##          NAME   AUTO_AR   ES27_AR   ES64_AR  AUTO_ADJ  ES27_ADJ  ES64_ADJ
## 1     Alabama 176.79786 176.96306 178.52469 171.95069 172.52208 177.73171
## 2     Arizona  66.90538  67.09085  67.65570  67.06929  63.08093  66.23576
## 3    Arkansas  36.02066  35.26628  35.49205  35.12591  35.52973  36.71324
## 4  California 260.52832 255.15947 252.74800 255.61425 247.38170 261.95766
## 5    Colorado 105.23882 103.34093 103.45301  99.62816 100.35423 106.69538
## 6 Connecticut  81.83815  82.48860  83.44493  79.07029  80.26900  87.33474
##    AUTO_TMP  ES27_TMP  ES64_TMP  AUTO_EPI  ES27_EPI  ES64_EPI Best_Result
## 1 175.99935 175.20471 179.15741 180.54717 178.18208 174.87487    AUTO_ADJ
## 2  66.82924  65.87824  66.15905  69.35285  67.99691  67.71082    ES27_ADJ
## 3  36.45988  35.66592  35.15920  36.66010  36.89276  36.66611    AUTO_ADJ
## 4 263.99879 259.19018 254.48401 270.69366 260.59695 261.69534    ES27_ADJ
## 5 105.29249 104.49503 104.66056 107.52025 105.35086 104.82870    AUTO_ADJ
## 6  82.32661  85.30291  88.43351  84.00331  82.09353  85.10770    AUTO_ADJ
```

```r
# --------- WEEK1 MODELS ------------- #
ggplot(W2,aes(x=Best_Result)) + geom_bar()+
  labs(title = "Best Model based on WIS for 47 U.S. states (2 Weeks Ahead)",
       x = "", y="Number of states")
```



WEEK 3

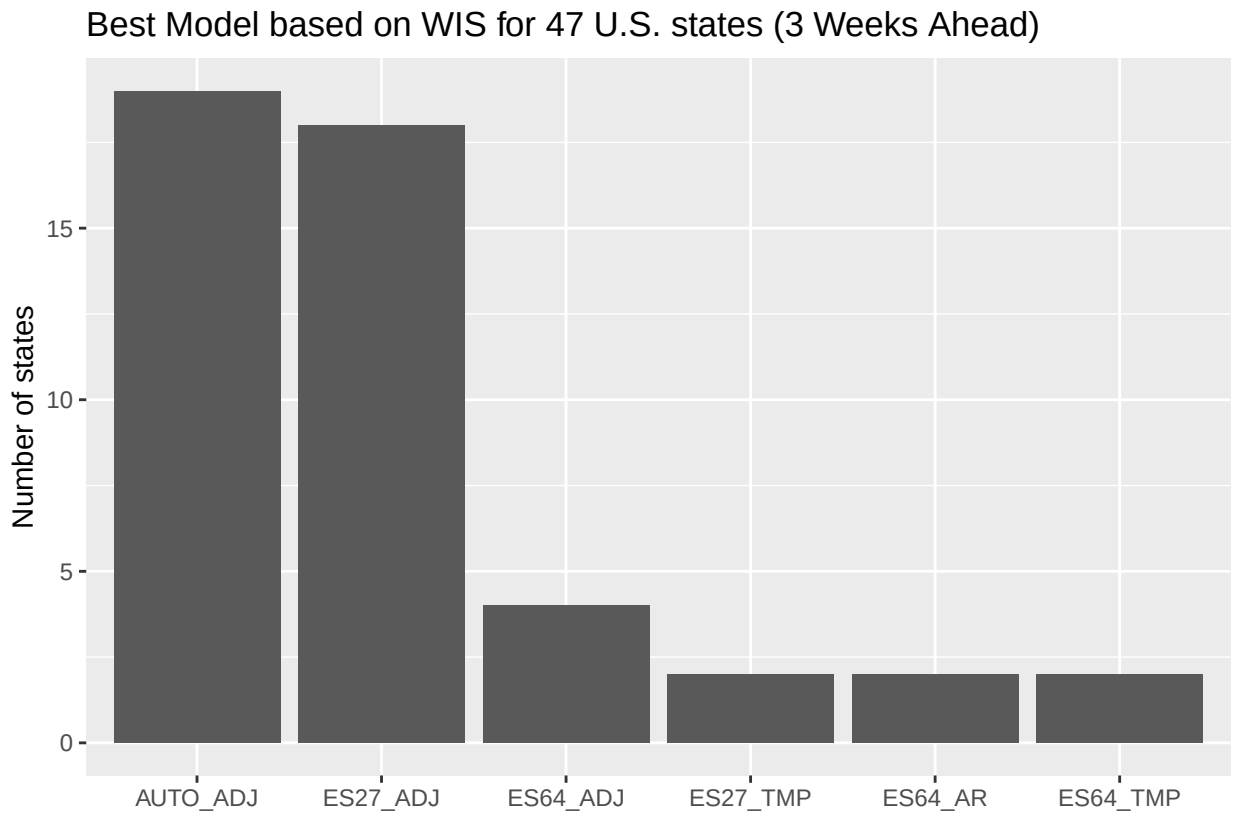
```
W3<-NULL

# AUTO ARIMA RESULTS
AUTO_AR_W3 <- calculate_mean_wis(AUTO_ARIMA_WEEK3_list)
ES27_AR_W3 <- calculate_mean_wis(ES27_ARIMA_WEEK3_list)
ES64_AR_W3 <- calculate_mean_wis(ES64_ARIMA_WEEK3_list)
# ADJACENT ARIMAX RESULTS
AUTO_ADJ_W3 <- calculate_mean_wis(AUTO_ADJACENT_WEEK3_list)
ES27_ADJ_W3 <- calculate_mean_wis(ES27_ADJACENT_WEEK3_list)
ES64_ADJ_W3 <- calculate_mean_wis(ES64_ADJACENT_WEEK3_list)
# TEMPERATURE ARIMAX RESULTS
AUTO_TMP_W3 <- calculate_mean_wis(AUTO_TEMPERATURE_WEEK3_list)
ES27_TMP_W3 <- calculate_mean_wis(ES27_TEMPERATURE_WEEK3_list)
ES64_TMP_W3 <- calculate_mean_wis(ES64_TEMPERATURE_WEEK3_list)
# EPIWEEK ARIMAX RESULTS
AUTO_EPI_W3 <- calculate_mean_wis(AUTO_EPIWEEK_WEEK3_list)
ES27_EPI_W3 <- calculate_mean_wis(ES27_EPIWEEK_WEEK3_list)
ES64_EPI_W3 <- calculate_mean_wis(ES64_EPIWEEK_WEEK3_list)

# MERGE
# AUTO ARIMA RESULTS
W3 <- merge(AUTO_AR_W3, ES27_AR_W3, by = "State")
W3 <- merge(W3, ES64_AR_W3, by = "State")
# ADJACENT ARIMAX RESULTS
```

```r
W3 <- merge(W3, AUTO_ADJ_W3, by = "State")
W3 <- merge(W3, ES27_ADJ_W3, by = "State")
W3 <- merge(W3, ES64_ADJ_W3, by = "State")
# TEMPERATURE ARIMAX RESULTS
W3 <- merge(W3, AUTO_TMP_W3, by = "State")
W3 <- merge(W3, ES27_TMP_W3, by = "State")
W3 <- merge(W3, ES64_TMP_W3, by = "State")
# EPIWEEK ARIMAX RESULTS
W3 <- merge(W3, AUTO_EPI_W3, by = "State")
W3 <- merge(W3, ES27_EPI_W3, by = "State")
W3 <- merge(W3, ES64_EPI_W3, by = "State")

# Rename columns for clarity
colnames(W3)[1] <- "NAME"
colnames(W3)[2] <- "AUTO_AR"
colnames(W3)[3] <- "ES27_AR"
colnames(W3)[4] <- "ES64_AR"
colnames(W3)[5] <- "AUTO_ADJ"
colnames(W3)[6] <- "ES27_ADJ"
colnames(W3)[7] <- "ES64_ADJ"
colnames(W3)[8] <- "AUTO_TMP"
colnames(W3)[9] <- "ES27_TMP"
colnames(W3)[10] <- "ES64_TMP"
colnames(W3)[11] <- "AUTO_EPI"
colnames(W3)[12] <- "ES27_EPI"
colnames(W3)[13] <- "ES64_EPI"

# Identify the best result for each state
#W3$Best_Result <- apply(W3[,2:13], 1, function(x) {
#  which.min(x)
#})

W3$Best_Result <- apply(W3[, 2:13], 1, function(x) {
  colnames(W3)[which.min(x) + 1]  # +1 to shift the index to account for column 1
})

# REORDER BY FREQUENCY
W3$Best_Result <- fct_infreq(W3$Best_Result)

# Print merged results
head(W3)
```

```
##          NAME   AUTO_AR   ES27_AR   ES64_AR  AUTO_ADJ  ES27_ADJ  ES64_ADJ
## 1     Alabama 235.22029 233.10051 233.25307 225.47845 228.68316 233.72299
## 2     Arizona  85.92363  86.98650  86.42503  89.34112  81.79289  86.83246
## 3    Arkansas  46.66508  45.96886  46.07627  43.84153  44.93023  47.18693
## 4  California 357.35130 347.97447 343.41673 353.63997 338.98427 360.02395
## 5    Colorado 142.30657 138.75233 138.96848 133.67369 136.41442 142.03129
## 6 Connecticut 106.74678 111.81782 110.64044 102.61978 105.16778 115.12742
##    AUTO_TMP  ES27_TMP  ES64_TMP  AUTO_EPI  ES27_EPI  ES64_EPI Best_Result
## 1 233.29858 230.85754 232.48676 236.44039 232.47689 227.20783    AUTO_ADJ
## 2  85.40273  84.04960  83.72061  90.40414  89.00180  88.16697    ES27_ADJ
## 3  46.92462  46.37374  43.97295  46.74298  47.21512  46.45097    AUTO_ADJ
```

```
## 4 361.10793 355.07486 348.09042 374.25618 359.89251 360.09505    ES27_ADJ
## 5 141.47293 140.57502 140.36094 143.39508 139.77563 139.55267    AUTO_ADJ
## 6 107.29540 115.28619 116.48950 108.21244 108.31155 110.32945    AUTO_ADJ
```

```
# --------- WEEK1 MODELS ------------- #
ggplot(W3,aes(x=Best_Result)) + geom_bar()+
  labs(title = "Best Model based on WIS for 47 U.S. states (3 Weeks Ahead)",
       x = "", y="Number of states")
```



WEEK 4

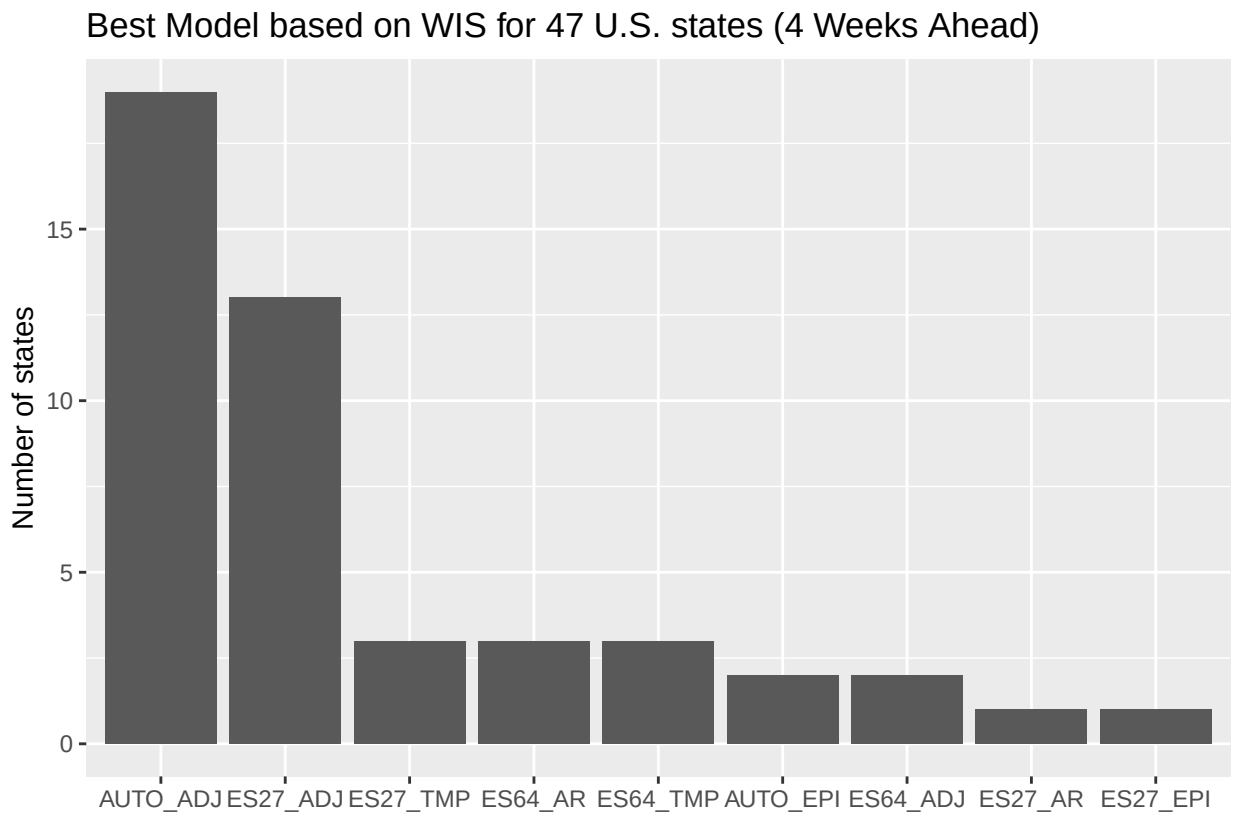
```
W4<-NULL

# AUTO ARIMA RESULTS
AUTO_AR_W4 <- calculate_mean_wis(AUTO_ARIMA_WEEK4_list)
ES27_AR_W4 <- calculate_mean_wis(ES27_ARIMA_WEEK4_list)
ES64_AR_W4 <- calculate_mean_wis(ES64_ARIMA_WEEK4_list)
# ADJACENT ARIMAX RESULTS
AUTO_ADJ_W4 <- calculate_mean_wis(AUTO_ADJACENT_WEEK4_list)
ES27_ADJ_W4 <- calculate_mean_wis(ES27_ADJACENT_WEEK4_list)
ES64_ADJ_W4 <- calculate_mean_wis(ES64_ADJACENT_WEEK4_list)
# TEMPERATURE ARIMAX RESULTS
AUTO_TMP_W4 <- calculate_mean_wis(AUTO_TEMPERATURE_WEEK4_list)
ES27_TMP_W4 <- calculate_mean_wis(ES27_TEMPERATURE_WEEK4_list)
ES64_TMP_W4 <- calculate_mean_wis(ES64_TEMPERATURE_WEEK4_list)
# EPIWEEK ARIMAX RESULTS
```

```r
AUTO_EPI_W4 <- calculate_mean_wis(AUTO_EPIWEEK_WEEK4_list)
ES27_EPI_W4 <- calculate_mean_wis(ES27_EPIWEEK_WEEK4_list)
ES64_EPI_W4 <- calculate_mean_wis(ES64_EPIWEEK_WEEK4_list)

# MERGE
# AUTO ARIMA RESULTS
W4 <- merge(AUTO_AR_W4, ES27_AR_W4, by = "State")
W4 <- merge(W4, ES64_AR_W4, by = "State")
# ADJACENT ARIMAX RESULTS
W4 <- merge(W4, AUTO_ADJ_W4, by = "State")
W4 <- merge(W4, ES27_ADJ_W4, by = "State")
W4 <- merge(W4, ES64_ADJ_W4, by = "State")
# TEMPERATURE ARIMAX RESULTS
W4 <- merge(W4, AUTO_TMP_W4, by = "State")
W4 <- merge(W4, ES27_TMP_W4, by = "State")
W4 <- merge(W4, ES64_TMP_W4, by = "State")
# EPIWEEK ARIMAX RESULTS
W4 <- merge(W4, AUTO_EPI_W4, by = "State")
W4 <- merge(W4, ES27_EPI_W4, by = "State")
W4 <- merge(W4, ES64_EPI_W4, by = "State")

# Rename columns for clarity
colnames(W4)[1] <- "NAME"
colnames(W4)[2] <- "AUTO_AR"
colnames(W4)[3] <- "ES27_AR"
colnames(W4)[4] <- "ES64_AR"
colnames(W4)[5] <- "AUTO_ADJ"
colnames(W4)[6] <- "ES27_ADJ"
colnames(W4)[7] <- "ES64_ADJ"
colnames(W4)[8] <- "AUTO_TMP"
colnames(W4)[9] <- "ES27_TMP"
colnames(W4)[10] <- "ES64_TMP"
colnames(W4)[11] <- "AUTO_EPI"
colnames(W4)[12] <- "ES27_EPI"
colnames(W4)[13] <- "ES64_EPI"

# Identify the best result for each state
#W4$Best_Result <- apply(W4[,2:13], 1, function(x) {
#  which.min(x)
#})

W4$Best_Result <- apply(W4[, 2:13], 1, function(x) {
  colnames(W4)[which.min(x) + 1]  # +1 to shift the index to account for column 1
})


W4$Best_Result <- fct_infreq(W4$Best_Result)

# Print merged results
head(W4)
```

```
##          NAME   AUTO_AR   ES27_AR   ES64_AR  AUTO_ADJ  ES27_ADJ  ES64_ADJ
## 1     Alabama 275.66774 271.88125 269.38839 261.97143 267.69536 276.10864
```

```
## 2     Arizona 102.79288 105.28864 104.04873 110.11997  99.88912 105.71256
## 3    Arkansas  55.71614  55.86489  55.51852  52.27712  53.97451  56.75355
## 4  California 454.04404 440.95016 431.53238 449.01139 429.54003 453.86590
## 5    Colorado 174.26179 170.52616 170.28629 162.99582 167.77916 172.18651
## 6 Connecticut 130.60123 146.54939 141.40292 122.84062 132.30592 142.95744
##    AUTO_TMP  ES27_TMP  ES64_TMP  AUTO_EPI  ES27_EPI  ES64_EPI Best_Result
## 1 274.93785 270.40965 268.35784 278.85890 269.67093 263.56600    AUTO_ADJ
## 2 102.77459 100.92540  99.46926 109.09777 107.06585 105.55045    ES64_TMP
## 3  56.16726  56.44215  52.45936  56.43826  57.19076  55.85982    AUTO_ADJ
## 4 454.72572 447.55868 437.97009 478.56280 456.37471 455.32237    ES27_ADJ
## 5 173.44942 172.78770 171.68062 174.27810 171.00633 170.60375    AUTO_ADJ
## 6 134.29882 150.17829 147.67298 133.59970 137.09017 139.77165    AUTO_ADJ
```

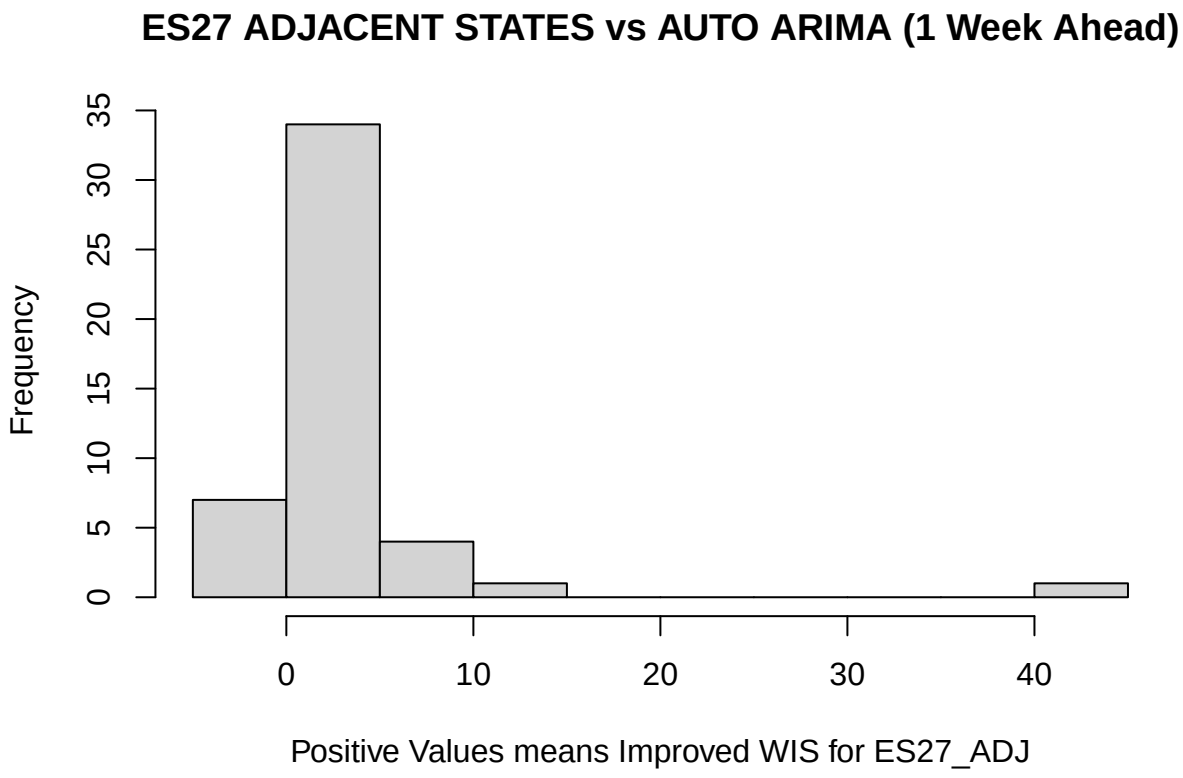
```
# --------- WEEK1 MODELS ------------- #
ggplot(W4,aes(x=Best_Result)) + geom_bar()+
  labs(title = "Best Model based on WIS for 47 U.S. states (4 Weeks Ahead)",
       x = "", y="Number of states")
```



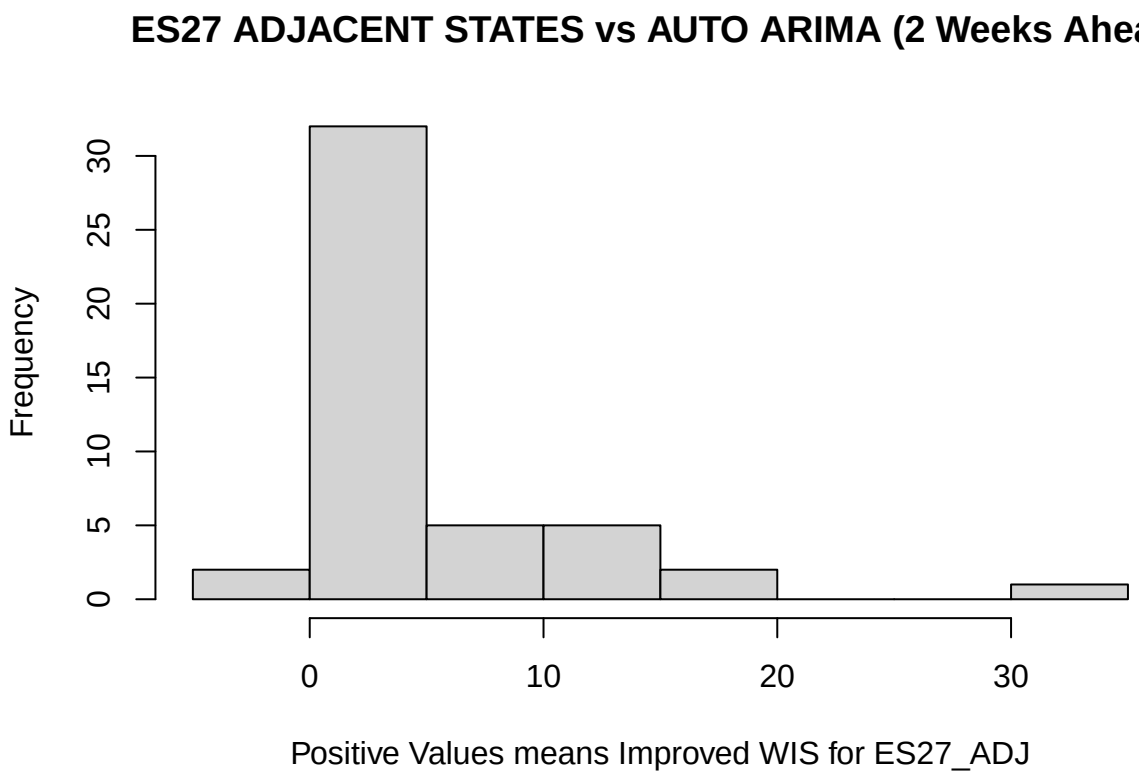
COMPARING AUTO ARIMA AND ADJACENT STATES ARIMAX WIS RESULTS FOR 1-4 WEEKS AHEAD

```
########
# WEEK1
W1_<-NULL
# AUTO ARIMA RESULTS
AUTO_AR_W1_ <- calculate_mean_wis(AUTO_ARIMA_WEEK1_list)
```

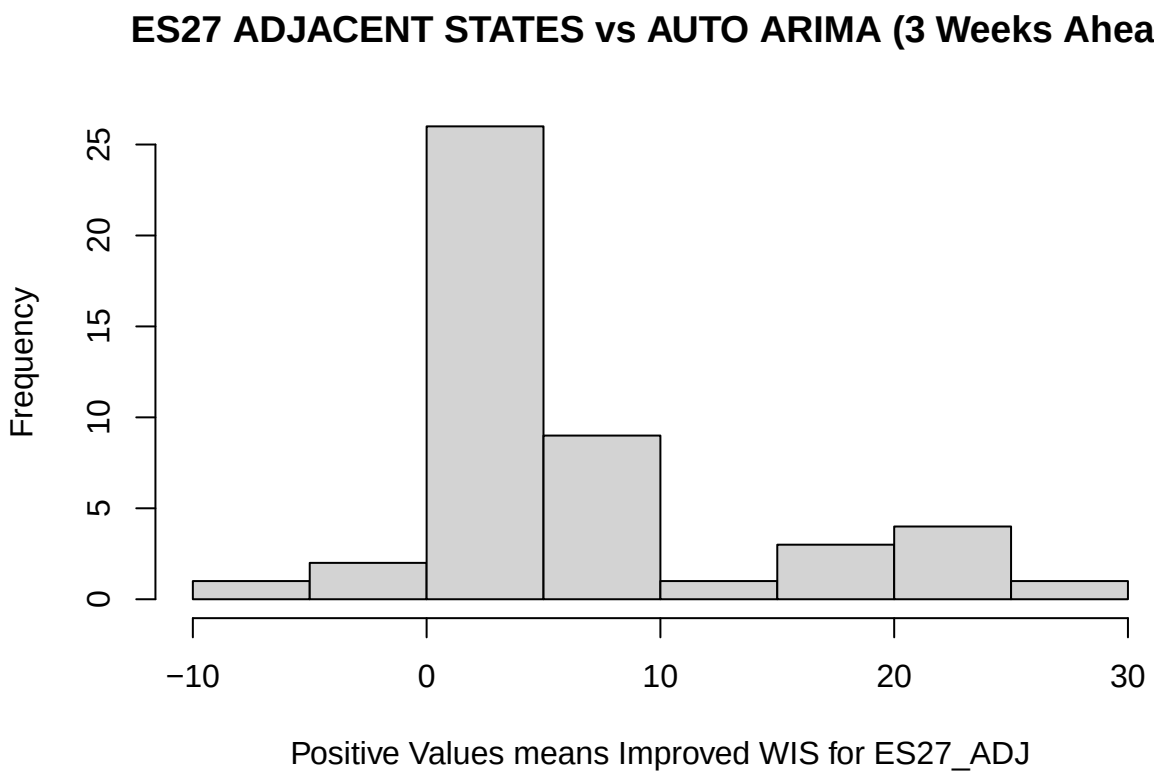
```r
ES27_ADJ_W1_ <- calculate_mean_wis(ES27_ADJACENT_WEEK1_list)
# AUTO ARIMA RESULTS
W1_ <- merge(AUTO_AR_W1_, ES27_ADJ_W1_, by = "State")
# Rename columns for clarity
colnames(W1_)[1] <- "NAME"
colnames(W1_)[2] <- "AUTO_AR"
colnames(W1_)[3] <- "ES27_ADJ"

########
# WEEK2
W2_<-NULL
# AUTO ARIMA RESULTS
AUTO_AR_W2_ <- calculate_mean_wis(AUTO_ARIMA_WEEK2_list)
ES27_ADJ_W2_ <- calculate_mean_wis(ES27_ADJACENT_WEEK2_list)
# AUTO ARIMA RESULTS
W2_ <- merge(AUTO_AR_W2_, ES27_ADJ_W2_, by = "State")
# Rename columns for clarity
colnames(W2_)[1] <- "NAME"
colnames(W2_)[2] <- "AUTO_AR"
colnames(W2_)[3] <- "ES27_ADJ"

########
# WEEK3
W3_<-NULL
# AUTO ARIMA RESULTS
AUTO_AR_W3_ <- calculate_mean_wis(AUTO_ARIMA_WEEK3_list)
ES27_ADJ_W3_ <- calculate_mean_wis(ES27_ADJACENT_WEEK3_list)
# AUTO ARIMA RESULTS
W3_ <- merge(AUTO_AR_W3_, ES27_ADJ_W3_, by = "State")
# Rename columns for clarity
colnames(W3_)[1] <- "NAME"
colnames(W3_)[2] <- "AUTO_AR"
colnames(W3_)[3] <- "ES27_ADJ"

########
# WEEK4
W4_<-NULL
# AUTO ARIMA RESULTS
AUTO_AR_W4_ <- calculate_mean_wis(AUTO_ARIMA_WEEK4_list)
ES27_ADJ_W4_ <- calculate_mean_wis(ES27_ADJACENT_WEEK4_list)
# AUTO ARIMA RESULTS
W4_ <- merge(AUTO_AR_W4_, ES27_ADJ_W4_, by = "State")
# Rename columns for clarity
colnames(W4_)[1] <- "NAME"
colnames(W4_)[2] <- "AUTO_AR"
colnames(W4_)[3] <- "ES27_ADJ"

# Improved WIS
hist(W1_$AUTO_AR-W1_$ES27_ADJ, main="ES27 ADJACENT STATES vs AUTO ARIMA (1 Week Ahead)", xlab = "Positi
```



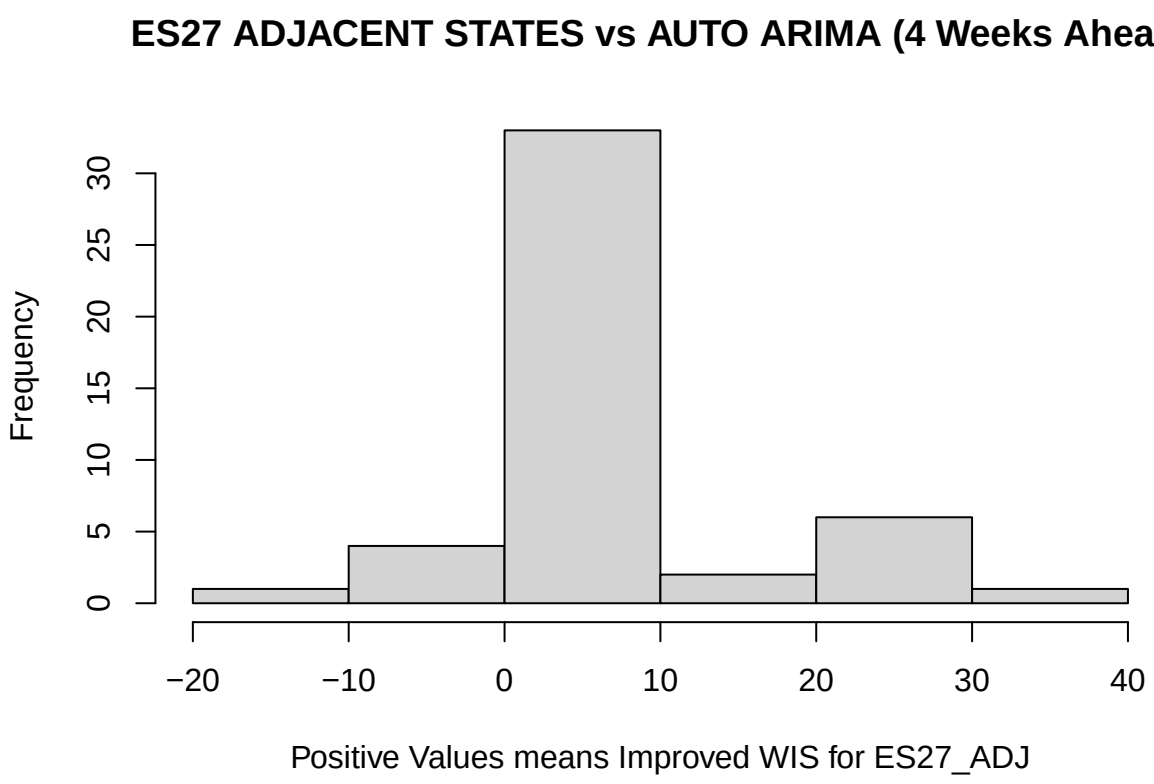

```
hist(W2_$AUTO_AR-W2_$ES27_ADJ, main="ES27 ADJACENT STATES vs AUTO ARIMA (2 Weeks Ahead)", xlab = "Positi
```




```
hist(W3_$AUTO_AR-W3_$ES27_ADJ, main="ES27 ADJACENT STATES vs AUTO ARIMA (3 Weeks Ahead)", xlab = "Positi
```

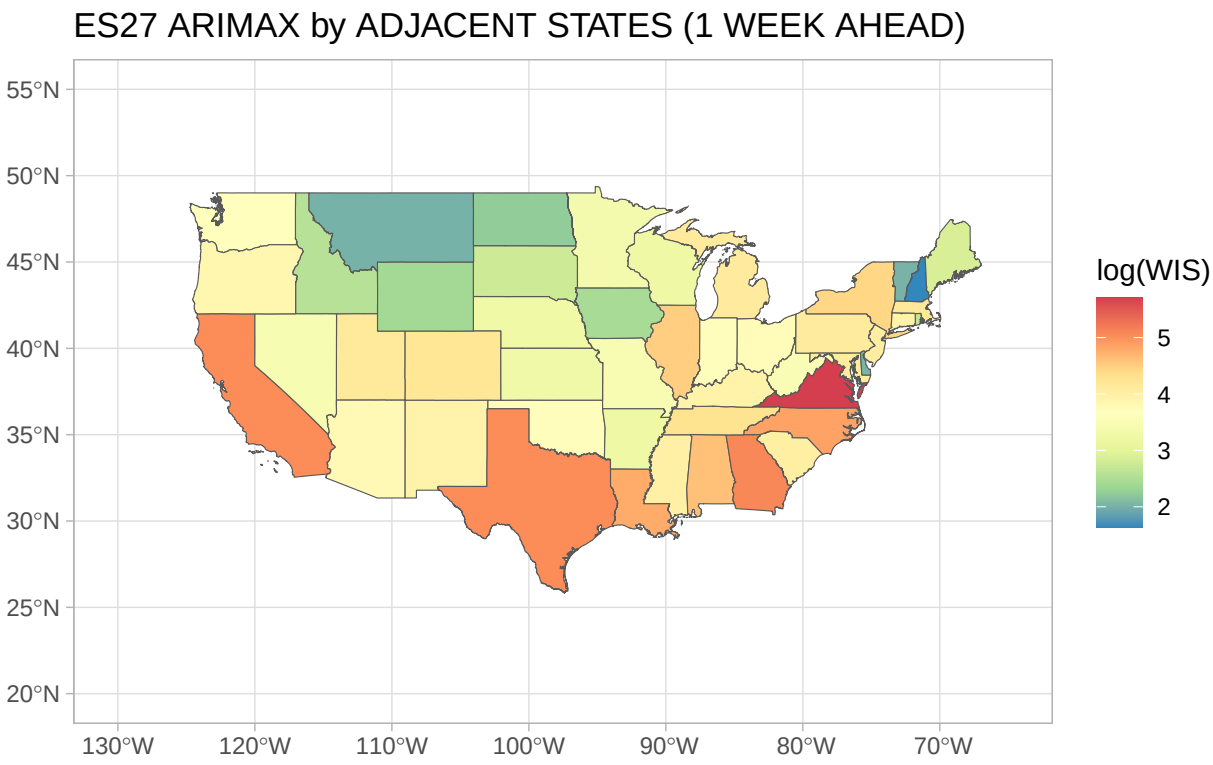



```
hist(W4_$AUTO_AR-W4_$ES27_ADJ, main="ES27 ADJACENT STATES vs AUTO ARIMA (4 Weeks Ahead)", xlab = "Positi
```

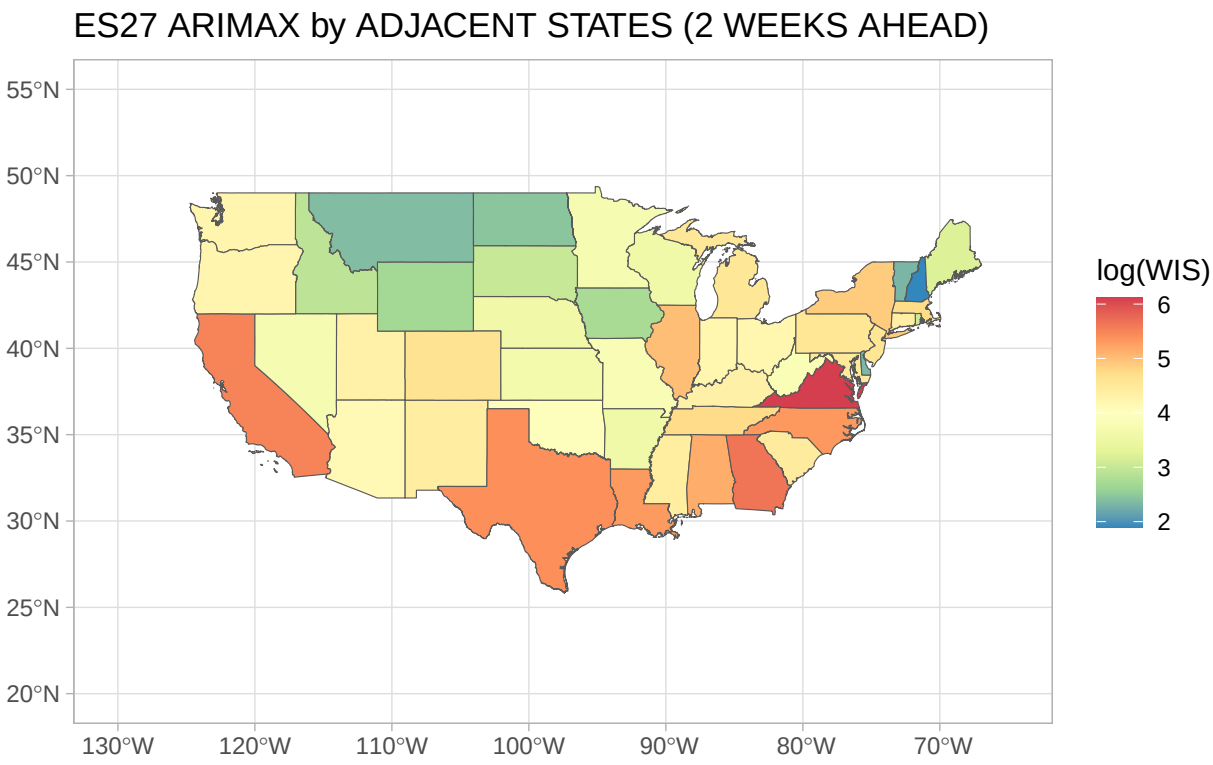


log(WIS) MAPS for 1-4 WEEKS AHEAD

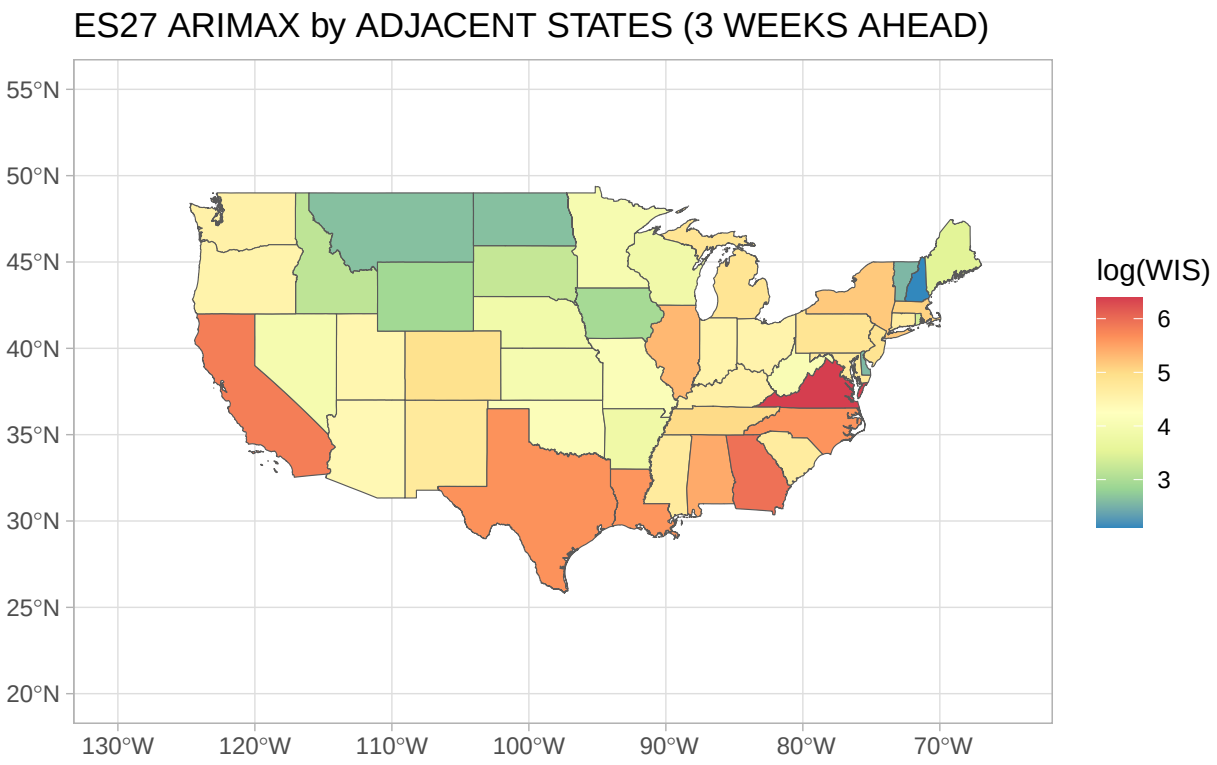
```
#########################################################
# MAPPING THE MEAN PERFORMANCE OF THE ES64, ES27      #
# AND AUTO ARIMA MODELS FOR THE 50 STATES OF THE U.S. #
# BASED ON THE SUMMARY RESULTS OF THE CURRENT MODELS. #
#########################################################

states <- read_sf("cb_2018_us_state_500k/cb_2018_us_state_500k.shp")

#################################################
# ES27 ARIMAX by ADJACENT STATES - 1 WEEK AHEAD #
#################################################

map_week1<-left_join(states, W1, by=join_by("NAME"))%>%
  drop_na()

ES_1WEEK<- ggplot(map_week1, fill ="lightgrey") +  theme_light()  + geom_sf(aes(fill=log(ES27_ADJ))) +

x_limits <- c(-130, -65)  # Set the desired longitude range
y_limits <- c(20, 55)     # Set the desired latitude range

ES_1WEEK + coord_sf(xlim = x_limits, ylim = y_limits)
```



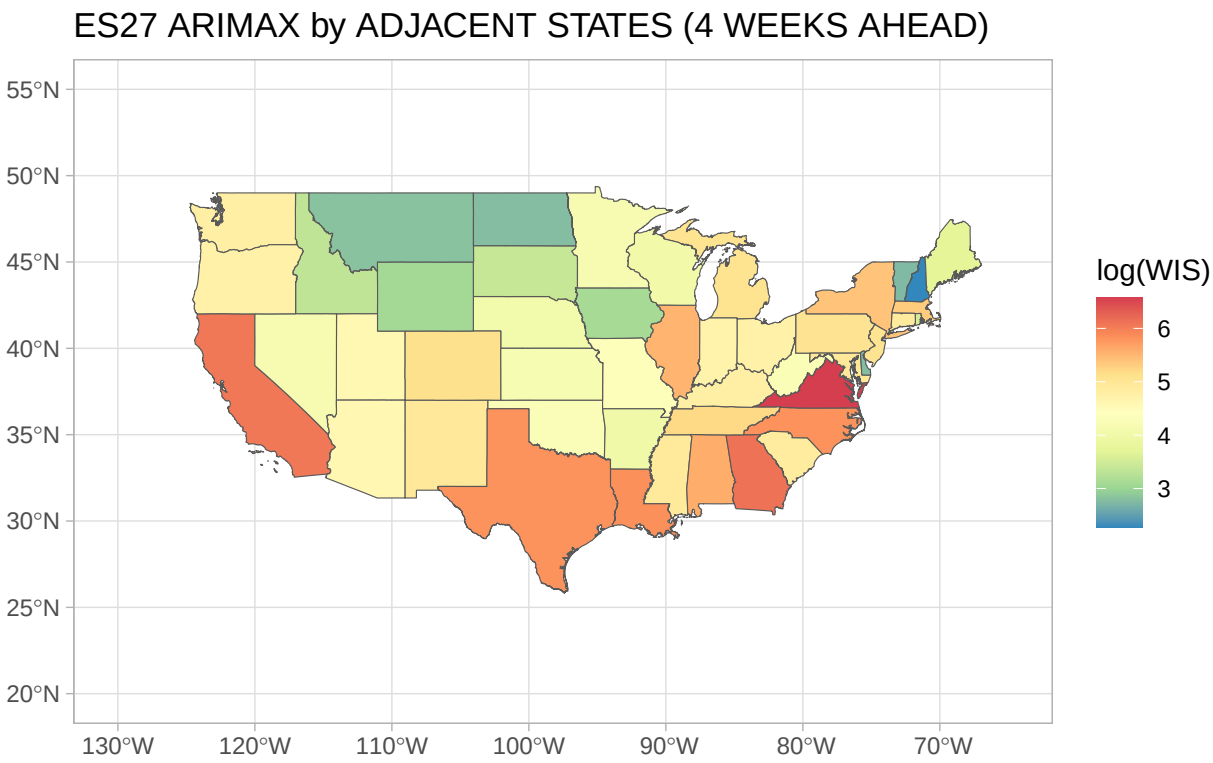

```
#####################################################
# ES27 ARIMAX by ADJACENT STATES - 2 WEEKS AHEAD #
#####################################################

map_week2<-left_join(states, W2, by=join_by("NAME"))%>%
  drop_na()

MAP_WEEK2<- ggplot(map_week2, fill ="lightgrey") +  theme_light()  + geom_sf(aes(fill=log(ES27_ADJ))) +

x_limits <- c(-130, -65)  # Set the desired longitude range
y_limits <- c(20, 55)    # Set the desired latitude range

MAP_WEEK2 + coord_sf(xlim = x_limits, ylim = y_limits)
```




```
#####################################################
# ES27 ARIMAX by ADJACENT STATES - 3 WEEKS AHEAD #
#####################################################

map_week3<-left_join(states, W3, by=join_by("NAME"))%>%
  drop_na()

MAP_WEEK3<- ggplot(map_week3, fill ="lightgrey") +  theme_light()  + geom_sf(aes(fill=log(ES27_ADJ))) +

x_limits <- c(-130, -65)  # Set the desired longitude range
y_limits <- c(20, 55)    # Set the desired latitude range

MAP_WEEK3 + coord_sf(xlim = x_limits, ylim = y_limits)
```




```
#####################################################
# ES27 ARIMAX by ADJACENT STATES - 4 WEEKS AHEAD #
#####################################################

map_week4<-left_join(states, W4, by=join_by("NAME"))%>%
  drop_na()

MAP_WEEK4<- ggplot(map_week4, fill ="lightgrey") +  theme_light()  + geom_sf(aes(fill=log(ES27_ADJ))) +

x_limits <- c(-130, -65)  # Set the desired longitude range
y_limits <- c(20, 55)    # Set the desired latitude range

MAP_WEEK4 + coord_sf(xlim = x_limits, ylim = y_limits)
```




```
ES27_ADJ_mean_wis_by_week<-data.frame("W1"= W1_$ES27_ADJ, "W2" = W2_$ES27_ADJ,"W3"= W3_$ES27_ADJ, "W4" =

# Convert to long format and add column number as ID
long_data <- ES27_ADJ_mean_wis_by_week %>%
  pivot_longer(
    cols = everything(),
    names_to = "variable",
    values_to = "value"
  ) %>%
  mutate(id = as.integer(factor(variable, levels = names(ES27_ADJ_mean_wis_by_week))))

# Print long format data
print(long_data)
```

```
## # A tibble: 188 x 3
##    variable value    id
##    <chr>    <dbl> <int>
##  1 W1       100.      1
##  2 W2       173.      2
##  3 W3       229.      3
##  4 W4       268.      4
##  5 W1        44.7     1
##  6 W2        63.1     2
##  7 W3        81.8     3
##  8 W4        99.9     4
```

```
##  9 W1        25.0     1
## 10 W2        35.5     2
## # i 178 more rows
```

```r
means <- aggregate(value ~ id, data = long_data, FUN = mean)

#-------------------------------------------------------------------------#
ggplot(long_data, aes(x = value)) +
  geom_histogram(binwidth = 8, fill = "blue", color = "black") +
  geom_vline(data = means, aes(xintercept = value), color = "red", linetype = "dashed") +
  facet_wrap(~ id, nrow = 2) +
  labs(title = "ES27 ADJACENT STATES - WIS for 47 U.S. states by N weeks ahead",
       x = "Weighted Interval Score (WIS)",
       y = "Number of states")  +
  theme_minimal()
```