INSTITUTO DE PESQUISA ECONÔMICA APLICADA – IPEA

A EFICIÊNCIA DAS POLÍTICAS DE SEGURANÇA PÚBLICA NO COMBATE A CRIMINALIDADE E A VIOLÊNCIA NA CIDADE DE SALVADOR NA BAHIA.

DISSERTAÇÃO DE MESTRADO

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BRASÍLIA-DF

2021

[AST - *Script* R]

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#################################################################
#                        PROJETO DA DISSERTAÇÃO                 #
#                          IPEA  MPPPD - 4 Turma                #
#                        Análise de Séries Temporais            #
#                        Forecasting - HoltWinters              #
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# Orientador:    Prof. Dr. Bernardo Alves Furtado          #
# Coorientador:  Prof. Dr. Alexandre dos Santos Cunha #
# Orientando:    Ricardo Wanner de Godoy                   #
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###################
# Versão: 03              #
# DAta:   04/11/2021  #
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# A EFICIÊNCIA DAS POLÍTICAS DE SEGURANÇA PÚBLICA NO COMBATE A #
# CRIMINALIDADE E A VIOLÊNCIA NA CIDADE DE SALVADOR NA BAHIA.   #
#############################################################################

# Instalação dos pacotes necessários no Script.

install.packages("fpp")
install.packages("fpp2")
install.packages("Quandl")
install.packages("xlsx")
install.packages("gridExtra")
install.packages("tidyverse")
install.packages("readr")
install.packages("dplyr")
install.packages("gapminder")
install.packages("Lahman")
install.packages("ggplot2")
install.packages("tidyr")
install.packages("psych")
install.packages("lubridate")
install.packages("forecast")
install.packages("ggfortify")
install.packages("extrafont")
```

```
library(Quandl)
library(fpp)
library(fpp2)
library(xlsx)
library(gridExtra)
library(tidyverse)
library(readr)
library(dplyr)
library(gapminder)
library(Lahman)
library(ggplot2)
library(tidyr)
library(psych)
library(lubridate)
library(forecast)
library(ggfortify)
library(extrafont)

#---------------------------------------------------------------------------------
# Carregando a fonte Times New Roman.

loadfonts(device = "win")

windowsFonts(Times=windowsFont("Times New Roman"))
#---------------------------------------------------------------------------------
# Carregando os dados no R.

DB_SSPBA = read.csv2("C:/Users/User/Desktop/DB_SSPBA_IPEA.csv", stringsAsFactors=FALSE)
str(DB_SSPBA)
View(DB_SSPBA)
#---------------------------------------------------------------------------------
# Legenda dos Eventos:

### Principais Delitos - Quantidade de Pessoas
# Homicídios Doloso                          = "H_D"
# Lesão Corporal Seguida de Morte            = "L_C_S_M"
# Roubo com Resultado Morte (Latrocínio)     = "R_c_R_M_L"
# Tentativa de Homicídios                    = "T_d_H"
# Estupro                                    = "Estpr"
#
#*********************************************************
#
### Principais Delitos - Quantidade de Ocorrências
# Roubo a Onibus_Urbano e em Rodovia               = "R_a_O_U_R"
# Roubo de Veículo                                 = "R_d_V"
# Furto de Veículo                                 = "F_d_V"
# Uso Porte Substância Entorpecente (Usuários)     = "U_P_S_E_U"
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#-------------------------------------------------------------------------------
# Legenda Cores:
# col = "steelblue4" = ts_DB_SSPBA2
#
# col = "brown" = ts_DB_SSPBA_PES
#
# col = "goldenrod4" = ts_DB_SSPBA_Oco
#-------------------------------------------------------------------------------
DB_SSPBA1 = DB_SSPBA

colnames(DB_SSPBA1)[1]  <- "Ano"
colnames(DB_SSPBA1)[3]  <- "H_D"
colnames(DB_SSPBA1)[4]  <- "L_C_S_M"
colnames(DB_SSPBA1)[5]  <- "R_c_R_M_L"
colnames(DB_SSPBA1)[6]  <- "T_d_H"
colnames(DB_SSPBA1)[7]  <- "Estpr"
colnames(DB_SSPBA1)[8]  <- "R_a_O_U_R"
colnames(DB_SSPBA1)[9]  <- "R_d_V"
colnames(DB_SSPBA1)[10] <- "F_d_V"
colnames(DB_SSPBA1)[11] <- "U_P_S_E_U"

str(DB_SSPBA1)
View(DB_SSPBA1)
class(DB_SSPBA1)
#-------------------------------------------------------------------------------
DB_SSPBA2 = DB_SSPBA1

DB_SSPBA2[,1] <- NULL
DB_SSPBA2[,1] <- NULL
#-------------------------------------------------------------------------------
# ### Principais Delitos - Quantidade de Pessoas
# ### &
# ### Principais Delitos - Quantidade de Ocorrências
#-------------------------------------------------------------------------------
DB_SSPBA2 = DB_SSPBA1

DB_SSPBA2[,1] <- NULL
DB_SSPBA2[,1] <- NULL
#-------------------------------------------------------------------------------
ts_DB_SSPBA2 = ts(DB_SSPBA2, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_SSPBA2)
View(ts_DB_SSPBA2)
class(ts_DB_SSPBA2)

ts_DB_SSPBA2
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#-------------------------------------------------------------------------------
autoplot(ts_DB_SSPBA2) +
      theme_bw() +
      labs(title ="Principais Delitos por Qtd de Pessoas ou de Ocorrências",
           subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
           x="Anos", y="Quantidade") +
       theme(plot.title = element_text(hjust = 0.5))+
       theme(plot.subtitle = element_text(hjust = 0.5))+
       scale_x_continuous(breaks = seq(from = 2014, 2021, 1)) +
       scale_colour_brewer(palette = "Set3") +
       guides(color = guide_legend(title="Principais Delitos")) +
       geom_line(linetype = 3, size = 1.2) +
       geom_point(lwd = 3) +
       geom_hline(aes(yintercept = mean(ts_DB_SSPBA2[ts_DB_SSPBA2 != 0])),
                  col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# Alteração da Fonte dos textos dos gráficos:

par(family = "serif")
#-------------------------------------------------------------------------------
boxplot(ts_DB_SSPBA2,
       main = "Principais Delitos por Qtd Pessoas(avermelhada) e Ocorrências(amarronzada) \n
       Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
       xlab = "Principais Delitos",
       ylab = "Quantidade",
       col = c("brown","brown","brown","brown","brown","goldenrod4","goldenrod4","goldenrod4","goldenrod4"),
       horizontal= FALSE,
       pch = 16)
#-------------------------------------------------------------------------------
plot(ts_DB_SSPBA2,
    type = "l", lwd = 2,
    col = "steelblue4",
    main = "Principais Delitos por Qtd Pessoas e Ocorrências",
    xlab = "Anos",
    ylab = "Principais Delitos")
#-------------------------------------------------------------------------------
summary(ts_DB_SSPBA2)
head(ts_DB_SSPBA2)
tail(ts_DB_SSPBA2)

decompose(ts_DB_SSPBA2)
#-------------------------------------------------------------------------------
# Diferença e Logaritmo dos Principais Delitos -
# Qtd de Pessoas e Ocorrências & Qtd de Pessoas e Ocorrências

diff_ts_DB_SSPBA2 = diff(ts_DB_SSPBA2)

plot.ts(diff_ts_DB_SSPBA2,
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      type = "l", lwd = 2,
      col = "steelblue4",
      main = "[diff] Principais Delitos por Qtd Pessoas e Ocorrências",
      xlab = "Anos",
      ylab = "Principais Delitos")
#------------------------------------------------------------------------------
log_ts_DB_SSPBA2 =log(ts_DB_SSPBA2)

plot.ts(log_ts_DB_SSPBA2,
      type = "l", lwd = 2,
      col = "steelblue4",
      main = "[log] Principais Delitos por Qtd Pessoas e Ocorrências",
      xlab = "Anos",
      ylab = "Principais Delitos")
#------------------------------------------------------------------------------
#******************************************************************************
#------------------------------------------------------------------------------
### Principais Delitos - Quantidade de Pessoas
#------------------------------------------------------------------------------
DB_SSPBA_PES = DB_SSPBA2

DB_SSPBA_PES[,6] <- NULL
DB_SSPBA_PES[,6] <- NULL
DB_SSPBA_PES[,6] <- NULL
DB_SSPBA_PES[,6] <- NULL
#------------------------------------------------------------------------------
ts_DB_SSPBA_PES = ts(DB_SSPBA_PES, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_SSPBA_PES)
View(ts_DB_SSPBA_PES)
class(ts_DB_SSPBA_PES)

ts_DB_SSPBA_PES
#------------------------------------------------------------------------------
autoplot(ts_DB_SSPBA_PES) +
      theme_bw() +
      labs(title ="Principais Delitos por Qtd de Pessoas",
          subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
          x="Anos", y="Quantidade") +
      theme(plot.title = element_text(hjust = 0.5)) +
      theme(plot.subtitle = element_text(hjust = 0.5)) +
      scale_x_continuous(breaks = seq(from = 2014, 2021, 1)) +
      scale_y_continuous(breaks = seq(from = 0, 30, 5)) +
      scale_colour_brewer(palette = "Set3") +
      guides(color = guide_legend(title="Principais Delitos")) +
      geom_line(linetype = 3, size = 1.2) +
      geom_point(lwd = 3) +
      geom_hline(aes(yintercept = mean(ts_DB_SSPBA_PES[ts_DB_SSPBA_PES != 0])),
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                col = "green", lwd = 0.1)
#-----------------------------------------------------------------------------------------
# Alteração da Fonte dos textos dos gráficos:

par(family = "serif")
#-----------------------------------------------------------------------------------------
boxplot(ts_DB_SSPBA_PES,
       main = "Principais Delitos por Qtd Pessoas(avermelhada)\n
       Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
       xlab = "Principais Delitos",
       ylab = "Quantidade",
       col = c("brown"),
       horizontal= FALSE,
       pch = 16)
#-----------------------------------------------------------------------------------------

plot(ts_DB_SSPBA_PES,
    type = "l", lwd = 2,
    col = "brown",
    main = "Principais Delitos por Qtd Pessoas",
    xlab = "Anos",
    ylab = "Principais Delitos")
#-----------------------------------------------------------------------------------------
summary(ts_DB_SSPBA_PES)
head(ts_DB_SSPBA_PES)
tail(ts_DB_SSPBA_PES)

decompose(ts_DB_SSPBA_PES)
#-----------------------------------------------------------------------------------------
# Diferença e Logaritmo dos Principais Delitos - Quantidade de Pessoas

diff_ts_DB_SSPBA_PES = diff(ts_DB_SSPBA_PES)

plot.ts(diff_ts_DB_SSPBA_PES,
       type = "l", lwd = 2,
       col = "brown",
       main = "[diff] Principais Delitos por Qtd Pessoas",
       xlab = "Anos",
       ylab = "Principais Delitos")
#-----------------------------------------------------------------------------------------

log_ts_DB_SSPBA_PES = log(ts_DB_SSPBA_PES)

plot.ts(log_ts_DB_SSPBA_PES,
       type = "l", lwd = 2,
       col = "brown",
       main = "[log] Principais Delitos por Qtd Pessoas",
       xlab = "Anos",
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      ylab = "Principais Delitos")
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Pessoas" = "Homicídios Doloso"
#-------------------------------------------------------------------------------
# TS somente com o Qtd Evento H_D = "Homicídios Doloso":

ts_DB_PES_H_D = ts(DB_SSPBA_PES$H_D, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_PES_H_D)
View(ts_DB_PES_H_D)
class(ts_DB_PES_H_D)

ts_DB_PES_H_D
#-------------------------------------------------------------------------------
# Alteração da Fonte dos textos dos gráficos:

par(family = "serif")
#-------------------------------------------------------------------------------
autoplot(ts_DB_PES_H_D, ts.colour = "brown", size = 1) +
      theme_bw() +
      labs(title ="Qtd de Homicídios Doloso(Pessoas) Por Ano",
         subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
         x = "Anos", y = "Quantidade") +
      theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
      theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
      scale_y_continuous(breaks = seq(from = 0, 30, 5)) +
      geom_hline(aes(yintercept = mean(ts_DB_PES_H_D[ts_DB_PES_H_D != 0])),
         col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
autoplot(ts_DB_PES_H_D, ts.geom = "point", shape = 3, size = 1.50,
       ts.colour = "brown") +
       theme_bw() +
       labs(title ="Qtd de Homicídios Doloso(Pessoas) Por Ano",
          subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
          x = "Anos", y = "Quantidade") +
       theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
       theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
       scale_y_continuous(breaks = seq(from = 0, 30, 5)) +
       geom_hline(aes(yintercept = mean(ts_DB_PES_H_D[ts_DB_PES_H_D != 0])),
              col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
ggseasonplot(ts_DB_PES_H_D, polar = T) +
         theme_bw() +
         labs(title ="Qtd de Homicídios Doloso(Pessoas) Por Ano/Mês",
            subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
            x="Meses", y="Quantidade") +
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        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        labs(color = "Anos") +
        scale_colour_brewer(palette = "Dark2") +
        geom_line(linetype = 3, size = 1.2) +
        geom_point(lwd = 3)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive

add_hw_PES_H_D = HoltWinters(ts_DB_PES_H_D, seasonal = "additive")

add_hw_PES_H_D

prev_add_hw_PES_H_D = forecast(add_hw_PES_H_D, h = 60, level = 80)

prev_add_hw_PES_H_D

autoplot(prev_add_hw_PES_H_D, size = 1, ts.colour = "brown") +
      theme_bw() +
      labs(title ="Qtd de Homicídios Doloso(Pessoas) com Previsão Aditiva + 5anos",
           subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
           x="Anos", y="Quantidade") +
      theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
      theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
      scale_y_continuous(breaks = seq(from = 0, 30, 7)) +
      geom_hline(yintercept = 0, col = "green", lwd = 0.1)
 #-------------------------------------------------------------------------------
# Forecasting - HoltWinters - multiplicative

mult_hw_PES_H_D = HoltWinters(ts_DB_PES_H_D, seasonal = "multiplicative")

mult_hw_PES_H_D


prev_mult_hw_PES_H_D = forecast(mult_hw_PES_H_D, h = 60, level = 80)

prev_mult_hw_PES_H_D

autoplot(prev_mult_hw_PES_H_D, size = 1, ts.colour = "brown") +
      theme_bw() +
      labs(title ="Qtd de Homicídios Doloso(Pessoas) com Previsão Multiplicativa + 5anos",
         subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
         x="Anos", y="Quantidade") +
      theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
      theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
      scale_y_continuous(breaks = seq(from = 0, 100, 20)) +
      geom_hline(yintercept = 0, col = "green", lwd = 0.1)
```

```
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Pessoas" = "Lesão Corporal Seguida de Morte"
#-------------------------------------------------------------------------------
# TS somente com o Qtd Evento L_C_S_M = "Lesão Corporal Seguida de Morte":

ts_DB_PES_L_C_S_M = ts(DB_SSPBA_PES$L_C_S_M, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_PES_L_C_S_M)
View(ts_DB_PES_L_C_S_M)
class(ts_DB_PES_L_C_S_M)

ts_DB_PES_L_C_S_M
#-------------------------------------------------------------------------------
autoplot(ts_DB_PES_L_C_S_M, ts.colour = "brown", size = 1) +
      theme_bw() +
      labs(title ="Qtd de Lesão Corporal Seguida de Morte(Pessoas) Por Ano",
         subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
         x = "Anos", y = "Quantidade") +
      theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
      theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
      scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
      geom_hline(aes(yintercept = mean(ts_DB_PES_L_C_S_M[ts_DB_PES_L_C_S_M != 0])),
               col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
autoplot(ts_DB_PES_L_C_S_M, ts.geom = "point", shape = 3, size = 1.50,
       ts.colour = "brown") +
      theme_bw() +
      labs(title ="Qtd de Lesão Corporal Seguida de Morte(Pessoas) Por Ano",
           subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
           x = "Anos", y = "Quantidade") +
      theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
      theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
      scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
      geom_hline(aes(yintercept = mean(ts_DB_PES_L_C_S_M[ts_DB_PES_L_C_S_M != 0])),
               col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
ggseasonplot(ts_DB_PES_L_C_S_M, polar = T) +
           theme_bw() +
           labs(title ="Qtd de Lesão Corporal Seguida de Morte(Pessoas) Por Ano/Mês",
                subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
                x="Meses", y="Quantidade") +
           theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
           theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
           labs(color = "Anos") +
           scale_colour_brewer(palette = "Dark2") +
           geom_line(linetype = 3, size = 1.2) +
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          geom_point(lwd = 3)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive

add_hw_PES_L_C_S_M = HoltWinters(ts_DB_PES_L_C_S_M, seasonal = "additive")

add_hw_PES_L_C_S_M

prev_add_hw_PES_L_C_S_M = forecast(add_hw_PES_L_C_S_M, h = 60, level = 80)

prev_add_hw_PES_L_C_S_M

autoplot(prev_add_hw_PES_L_C_S_M, size = 1, ts.colour = "brown") +
        theme_bw() +
        labs(title ="Qtd de Lesão Corporal Seguida de Morte(Pessoas) com Previsão Aditiva + 5anos",
             subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
             x="Anos", y="Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - multiplicative

# mult_hw_PES_L_C_S_M = HoltWinters(ts_DB_PES_L_C_S_M, seasonal = "multiplicative")
#
# mult_hw_PES_L_C_S_M
#
#
# prev_mult_hw_PES_L_C_S_M = forecast(mult_hw_PES_L_C_S_M, h = 60, level = 80)
#
# prev_mult_hw_PES_L_C_S_M
#
#
# autoplot(prev_mult_hw_PES_L_C_S_M, size = 1, ts.colour = "brown") +
#         theme_bw() +
#         labs(title ="Qtd de Lesão Corporal Seguida de Morte(Pessoas) com Previsão Multiplicativa + 5anos",
#              subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
#              x="Anos", y="Quantidade") +
#         theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
#         theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
#         scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
#         geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Pessoas" = "Roubo com Resultado Morte (Latrocínio)"
#-------------------------------------------------------------------------------
```

```
# TS somente com o Qtd Evento R_c_R_M_L = "Roubo com Resultado Morte (Latrocínio)":

ts_DB_PES_R_c_R_M_L = ts(DB_SSPBA_PES$R_c_R_M_L, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_PES_R_c_R_M_L)
View(ts_DB_PES_R_c_R_M_L)
class(ts_DB_PES_R_c_R_M_L)

ts_DB_PES_R_c_R_M_L
#-------------------------------------------------------------------------------
autoplot(ts_DB_PES_R_c_R_M_L, ts.colour = "brown", size = 1) +
        theme_bw() +
        labs(title ="Qtd de Roubo com Resultado Morte_Latrocínio(Pessoas) Por Ano",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
        geom_hline(aes(yintercept = mean(ts_DB_PES_R_c_R_M_L[ts_DB_PES_R_c_R_M_L != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
autoplot(ts_DB_PES_R_c_R_M_L, ts.geom = "point", shape = 3, size = 1.50,
        ts.colour = "brown") +
        theme_bw() +
        labs(title ="Qtd de Roubo com Resultado Morte_Latrocínio(Pessoas) Por Ano",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
        geom_hline(aes(yintercept = mean(ts_DB_PES_R_c_R_M_L[ts_DB_PES_R_c_R_M_L != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
ggseasonplot(ts_DB_PES_R_c_R_M_L, polar = T) +
           theme_bw() +
           labs(title ="Qtd de Roubo com Resultado Morte_Latrocínio(Pessoas) Por Ano/Mês",
                subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
                x="Meses", y="Quantidade") +
           theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
           theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
           labs(color = "Anos") +
           scale_colour_brewer(palette = "Dark2") +
           scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
           geom_line(linetype = 3, size = 1.2) +
           geom_point(lwd = 3)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive
```

```
add_hw_PES_R_c_R_M_L = HoltWinters(ts_DB_PES_R_c_R_M_L, seasonal = "additive")

add_hw_PES_R_c_R_M_L

prev_add_hw_PES_R_c_R_M_L = forecast(add_hw_PES_R_c_R_M_L, h = 60, level = 80)

prev_add_hw_PES_R_c_R_M_L

autoplot(prev_add_hw_PES_R_c_R_M_L, size = 1, ts.colour = "brown") +
        theme_bw() +
        labs(title ="Qtd de Roubo com Resultado Morte_Latrocínio(Pessoas) com Previsão Aditiva + 5anos",
             subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
             x="Anos", y="Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - multiplicative

# mult_hw_PES_R_c_R_M_L = HoltWinters(ts_DB_PES_R_c_R_M_L, seasonal = "multiplicative")
#
# mult_hw_PES_R_c_R_M_L
#
# prev_mult_hw_PES_R_c_R_M_L = forecast(mult_hw_PES_R_c_R_M_L, h = 60, level = 80)
#
# prev_mult_hw_PES_R_c_R_M_L
#
# autoplot(prev_mult_hw_PES_R_c_R_M_L, size = 1, ts.colour = "brown") +
#         theme_bw() +
#         labs(title ="Qtd de Roubo com Resultado Morte_Latrocínio(Pessoas) com Previsão Multiplicativa + 5anos",
#              subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
#              x="Anos", y="Quantidade") +
#         theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
#         theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
#         scale_y_continuous(breaks = seq(from = 0, 5, 1)) +
#         geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Pessoas" = "Tentativa de Homicídio"
#-------------------------------------------------------------------------------
# TS somente com o Qtd Evento "Tentativa de Homicídio" = "T_d_H":

ts_DB_PES_T_d_H = ts(DB_SSPBA_PES$T_d_H, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_PES_T_d_H)
View(ts_DB_PES_T_d_H)
```

```
class(ts_DB_PES_T_d_H)

ts_DB_PES_T_d_H
#-----------------------------------------------------------------------------------------
autoplot(ts_DB_PES_T_d_H, ts.colour = "brown", size = 1) +
        theme_bw() +
        labs(title ="Qtd de Tentativa de Homicídio(Pessoas) Por Ano",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 20, 3)) +
        geom_hline(aes(yintercept = mean(ts_DB_PES_T_d_H[ts_DB_PES_T_d_H != 0])),
                   col = "green", lwd = 0.1)
#-----------------------------------------------------------------------------------------
autoplot(ts_DB_PES_T_d_H, ts.geom = "point", shape = 3, size = 1.50,
       ts.colour = "brown") +
        theme_bw() +
        labs(title ="Qtd de Tentativa de Homicídio(Pessoas) Por Ano",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 20, 3)) +
        geom_hline(aes(yintercept = mean(ts_DB_PES_T_d_H[ts_DB_PES_T_d_H != 0])),
                   col = "green", lwd = 0.1)
#-----------------------------------------------------------------------------------------
ggseasonplot(ts_DB_PES_T_d_H, polar = T) +
           theme_bw() +
           labs(title ="Qtd de Tentativa de Homicídio(Pessoas) Por Ano/Mês",
                subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
                x="Meses", y="Quantidade") +
           theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
           theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
           labs(color = "Anos") +
           scale_colour_brewer(palette = "Dark2") +
           scale_y_continuous(breaks = seq(from = 0, 20, 5)) +
           geom_line(linetype = 3, size = 1.2) +
           geom_point(lwd = 3)
#-----------------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive

add_hw_PES_T_d_H = HoltWinters(ts_DB_PES_T_d_H, seasonal = "additive")

add_hw_PES_T_d_H
prev_add_hw_PES_T_d_H = forecast(add_hw_PES_T_d_H, h = 60, level = 80)

prev_add_hw_PES_T_d_H
```

```
autoplot(prev_add_hw_PES_T_d_H, size = 1, ts.colour = "brown") +
        theme_bw() +
        labs(title ="Qtd de Tentativa de Homicídio(Pessoas) com Previsão Aditiva + 5anos",
             subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
             x="Anos", y="Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 30, 5)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# # Forecasting - HoltWinters - multiplicative
#
# mult_hw_PES_T_d_H = HoltWinters(ts_DB_PES_T_d_H, seasonal = "multiplicative")
#
# mult_hw_PES_T_d_H
#
# prev_mult_hw_PES_T_d_H = forecast(mult_hw_PES_T_d_H, h = 60, level = 80)
#
# prev_mult_hw_PES_T_d_H
#
# autoplot(prev_mult_hw_PES_T_d_H, size = 1, ts.colour = "brown") +
#          theme_bw() +
#          labs(title ="Qtd de Tentativa de Homicídio(Pessoas) com Previsão Multiplicativa + 5anos",
#               subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
#               x="Anos", y="Quantidade") +
#          theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
#          theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
#          scale_y_continuous(breaks = seq(from = 0, 30, 5)) +
#          geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Pessoas" = "Estupro"
#-------------------------------------------------------------------------------
# TS somente com o Qtd Evento Estpr = "Estupro":

ts_DB_PES_Estpr = ts(DB_SSPBA_PES$Estpr, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_PES_Estpr)
View(ts_DB_PES_Estpr)
class(ts_DB_PES_Estpr)

ts_DB_PES_Estpr
#-------------------------------------------------------------------------------
autoplot(ts_DB_PES_Estpr, ts.colour = "brown", size = 1) +
        theme_bw() +
        labs(title ="Qtd de Estupro(Pessoas) Por Ano",
```

```
            subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
            x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 20, 4)) +
        geom_hline(aes(yintercept = mean(ts_DB_PES_Estpr[ts_DB_PES_Estpr != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------------
autoplot(ts_DB_PES_Estpr, ts.geom = "point", shape = 3, size = 1.50,
       ts.colour = "brown") +
        theme_bw() +
        labs(title ="Qtd de Estupro(Pessoas) Por Ano",
            subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
            x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 20, 4)) +
        geom_hline(aes(yintercept = mean(ts_DB_PES_Estpr[ts_DB_PES_Estpr != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------------
ggseasonplot(ts_DB_PES_Estpr, polar = T) +
           theme_bw() +
           labs(title ="Qtd de Estupro(Pessoas) Por Ano/Mês",
                subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
                x="Meses", y="Quantidade") +
           theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
           theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
           labs(color = "Anos") +
           scale_colour_brewer(palette = "Dark2") +
           scale_y_continuous(breaks = seq(from = 0, 20, 4)) +
           geom_line(linetype = 3, size = 1.2) +
           geom_point(lwd = 3)
#-------------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive

add_hw_PES_Estpr = HoltWinters(ts_DB_PES_Estpr, seasonal = "additive")

add_hw_PES_Estpr

prev_add_hw_PES_Estpr = forecast(add_hw_PES_Estpr, h = 60, level = 80)

prev_add_hw_PES_Estpr

autoplot(prev_add_hw_PES_Estpr, size = 1, ts.colour = "brown") +
        theme_bw() +
        labs(title ="Qtd de Estupro(Pessoas) com Previsão Aditiva + 5anos",
            subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
            x="Anos", y="Quantidade") +
```

```
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 20, 4)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - multiplicative

# mult_hw_PES_Estpr = HoltWinters(ts_DB_PES_Estpr, seasonal = "multiplicative")
#
# mult_hw_PES_Estpr
#
# prev_mult_hw_PES_Estpr = forecast(mult_hw_PES_Estpr, h = 60, level = 80)
#
# prev_mult_hw_PES_Estpr
#
# autoplot(prev_mult_hw_PES_Estpr, size = 1, ts.colour = "brown") +
#          theme_bw() +
#          labs(title ="Qtd de Estupro(Pessoas) com Previsão Multiplicativa + 5anos",
#               subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
#               x="Anos", y="Quantidade") +
#          theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
#          theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
#          scale_y_continuous(breaks = seq(from = 0, 20, 4)) +
#          geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
#*******************************************************************************
#*******************************************************************************
#-------------------------------------------------------------------------------
### Principais Delitos - Quantidade de Ocorrências
#-------------------------------------------------------------------------------
DB_SSPBA_Oco = DB_SSPBA2

DB_SSPBA_Oco[,1] <- NULL
DB_SSPBA_Oco[,1] <- NULL
DB_SSPBA_Oco[,1] <- NULL
DB_SSPBA_Oco[,1] <- NULL
DB_SSPBA_Oco[,1] <- NULL
#-------------------------------------------------------------------------------
ts_DB_SSPBA_Oco = ts(DB_SSPBA_Oco, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_SSPBA_Oco)
View(ts_DB_SSPBA_Oco)
class(ts_DB_SSPBA_Oco)

ts_DB_SSPBA_Oco
#-------------------------------------------------------------------------------
autoplot(ts_DB_SSPBA_Oco) +
        theme_bw() +
```

```
        labs(title ="Principais Delitos por Qtd de Ocorrências",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x="Anos", y="Quantidade") +
        theme(plot.title = element_text(hjust = 0.5)) +
        theme(plot.subtitle = element_text(hjust = 0.5)) +
        scale_x_continuous(breaks = seq(from = 2014, 2021, 1)) +
        scale_y_continuous(breaks = seq(from = 0, 80, 10)) +
        scale_colour_brewer(palette = "Set3") +
        guides(color = guide_legend(title="Principais Delitos")) +
        geom_line(linetype = 3, size = 1.2) +
        geom_point(lwd = 3) +
        geom_hline(aes(yintercept = mean(ts_DB_SSPBA_Oco[ts_DB_SSPBA_Oco != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------------
# Alteração da Fonte dos textos dos gráficos:

par(family = "serif")
#-------------------------------------------------------------------------------------
boxplot(ts_DB_SSPBA_Oco,
       main = "Principais Delitos por Qtd Ocorrências(amarronzada)\n
       Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
       xlab = "Principais Delitos",
       ylab = "Quantidade",
       col = "goldenrod4",
       horizontal= FALSE,
       pch = 16)
#-------------------------------------------------------------------------------------
plot(ts_DB_SSPBA_Oco,
    type = "l", lwd = 2,
    col = "goldenrod4",
    main = "Principais Delitos por Qtd Ocorrências",
    xlab = "Anos",
    ylab = "Eventos")
#-------------------------------------------------------------------------------------
summary(ts_DB_SSPBA_Oco)
head(ts_DB_SSPBA_Oco)
tail(ts_DB_SSPBA_Oco)

decompose(ts_DB_SSPBA_Oco)
#-------------------------------------------------------------------------------------
# Diferença e Logaritmo dos Principais Delitos - Quantidade de Ocorrências

diff_ts_DB_SSPBA_Oco = diff(ts_DB_SSPBA_Oco)

plot.ts(diff_ts_DB_SSPBA_Oco,
       type = "l", lwd = 2,
       col = "goldenrod4",
       main = "[diff] Principais Delitos por Qtd Ocorrências",
```

```
      xlab = "Anos",
      ylab = "Principais Delitos")
#-------------------------------------------------------------------------------
log_ts_DB_SSPBA_Oco = log(ts_DB_SSPBA_Oco)

plot.ts(log_ts_DB_SSPBA_Oco,
      type = "l", lwd = 2,
      col = "goldenrod4",
      main = "[log] Principais Delitos por Qtd Ocorrências",
      xlab = "Anos",
      ylab = "Principais Delitos")
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Ocorrências" = "Roubo a Onibus_Urbano e em Rodovia"
#-------------------------------------------------------------------------------
# TS somente com o Qtd de Evento R_a_O_U_R = "Roubo a Onibus_Urbano e em Rodovia":

ts_DB_Oco_R_a_O_U_R = ts(DB_SSPBA_Oco$R_a_O_U_R, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_Oco_R_a_O_U_R)
View(ts_DB_Oco_R_a_O_U_R)
class(ts_DB_Oco_R_a_O_U_R)

ts_DB_Oco_R_a_O_U_R
#-------------------------------------------------------------------------------
autoplot(ts_DB_Oco_R_a_O_U_R, ts.colour = "goldenrod4", size = 1) +
       theme_bw() +
       labs(title ="Qtd de Roubo a Onibus_Urbano e em Rodovia(Ocorrências) Por Ano",
            subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
            x = "Anos", y = "Quantidade") +
       theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
       theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
       scale_y_continuous(breaks = seq(from = 0, 80, 10)) +
       geom_hline(aes(yintercept = mean(ts_DB_Oco_R_a_O_U_R[ts_DB_Oco_R_a_O_U_R != 0])),
                  col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
autoplot(ts_DB_Oco_R_a_O_U_R, ts.geom = "point", shape = 3, size = 1.50,
       ts.colour = "goldenrod4") +
       theme_bw() +
       labs(title ="Qtd de Roubo a Onibus_Urbano e em Rodovia(Ocorrências) Por Ano",
            subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
            x = "Anos", y = "Quantidade") +
       theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
       theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
       scale_y_continuous(breaks = seq(from = 0, 80, 10)) +
       geom_hline(aes(yintercept = mean(ts_DB_Oco_R_a_O_U_R[ts_DB_Oco_R_a_O_U_R != 0])),
                  col = "green", lwd = 0.1)
```

```
#-------------------------------------------------------------------------------
ggseasonplot(ts_DB_Oco_R_a_O_U_R, polar = T) +
          theme_bw() +
          labs(title ="Qtd de Roubo a Onibus_Urbano e em Rodovia(Ocorrências) Por Ano/Mês",
               subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
               x="Meses", y="Quantidade") +
          theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
          theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
          labs(color = "Anos") +
          scale_colour_brewer(palette = "Dark2") +
          scale_y_continuous(breaks = seq(from = 0, 80, 15)) +
          geom_line(linetype = 3, size = 1.2) +
          geom_point(lwd = 3)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive

add_hw_Oco_R_a_O_U_R = HoltWinters(ts_DB_Oco_R_a_O_U_R, seasonal = "additive")

add_hw_Oco_R_a_O_U_R

prev_add_hw_Oco_R_a_O_U_R = forecast(add_hw_Oco_R_a_O_U_R, h = 60, level = 80)

prev_add_hw_Oco_R_a_O_U_R

autoplot(prev_add_hw_Oco_R_a_O_U_R, size = 1, ts.colour = "goldenrod4") +
        theme_bw() +
        labs(title ="Qtd de Roubo a Onibus_Urbano e em Rodovia(Ocorrências) com Previsão Aditiva + 5anos",
             subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
             x="Anos", y="Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 130, 25)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - multiplicative

mult_hw_Oco_R_a_O_U_R = HoltWinters(ts_DB_Oco_R_a_O_U_R, seasonal = "multiplicative")

mult_hw_Oco_R_a_O_U_R

prev_mult_hw_Oco_R_a_O_U_R = forecast(mult_hw_Oco_R_a_O_U_R, h = 60, level = 80)

prev_mult_hw_Oco_R_a_O_U_R

autoplot(prev_mult_hw_Oco_R_a_O_U_R, size = 1, ts.colour = "goldenrod4") +
        theme_bw() +
       labs(title ="Qtd de Roubo a Onibus_Urbano e em Rodovia(Ocorrências) com Previsão Multiplicativa + 5anos",
            subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
```

```
            x="Anos", y="Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 1000, 200)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Ocorrências" = "Roubo de Veículo"
#-------------------------------------------------------------------------------
# TS somente com o Qtd de Evento R_d_V = "Roubo de Veículo":

ts_DB_Oco_R_d_V = ts(DB_SSPBA_Oco$R_d_V, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_Oco_R_d_V)
View(ts_DB_Oco_R_d_V)
class(ts_DB_Oco_R_d_V)

ts_DB_Oco_R_d_V
#-------------------------------------------------------------------------------
autoplot(ts_DB_Oco_R_d_V, ts.colour = "goldenrod4", size = 1) +
        theme_bw() +
        labs(title ="Qtd de Roubo de Veículo(Ocorrências) Por Ano",
            subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
            x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 80, 10)) +
        geom_hline(aes(yintercept = mean(ts_DB_Oco_R_d_V[ts_DB_Oco_R_d_V != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
autoplot(ts_DB_Oco_R_d_V, ts.geom = "point", shape = 3, size = 1.50,
       ts.colour = "goldenrod4") +
        theme_bw() +
        labs(title ="Qtd de Roubo de Veículo(Ocorrências) Por Ano",
            subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
            x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 80, 10)) +
        geom_hline(aes(yintercept = mean(ts_DB_Oco_R_d_V[ts_DB_Oco_R_d_V != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
ggseasonplot(ts_DB_Oco_R_d_V, polar = T) +
           theme_bw() +
           labs(title ="Qtd de Roubo de Veículo(Ocorrências) Por Ano/Mês",
               subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
               x="Meses", y="Quantidade") +
```

```
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        labs(color = "Anos") +
        scale_colour_brewer(palette = "Dark2") +
        scale_y_continuous(breaks = seq(from = 0, 80, 10)) +
        geom_line(linetype = 3, size = 1.2) +
        geom_point(lwd = 3)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive

add_hw_Oco_R_d_V = HoltWinters(ts_DB_Oco_R_d_V, seasonal = "additive")

add_hw_Oco_R_d_V


prev_add_hw_Oco_R_d_V = forecast(add_hw_Oco_R_d_V, h = 60, level = 80)

prev_add_hw_Oco_R_d_V

autoplot(prev_add_hw_Oco_R_d_V, size = 1, ts.colour = "goldenrod4") +
      theme_bw() +
      labs(title ="Qtd de Roubo de Veículo(Ocorrências) com Previsão Aditiva + 5anos",
           subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
           x="Anos", y="Quantidade") +
      theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
      theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
      scale_y_continuous(breaks = seq(from = 0, 80, 20)) +
      geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - multiplicative

mult_hw_Oco_R_d_V = HoltWinters(ts_DB_Oco_R_d_V, seasonal = "multiplicative")

mult_hw_Oco_R_d_V

prev_mult_hw_Oco_R_d_V = forecast(mult_hw_Oco_R_d_V, h = 60, level = 80)

prev_mult_hw_Oco_R_d_V

autoplot(prev_mult_hw_Oco_R_d_V, size = 1, ts.colour = "goldenrod4") +
      theme_bw() +
      labs(title ="Qtd de Roubo de Veículo(Ocorrências) com Previsão Multiplicativa + 5anos",
           subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
           x="Anos", y="Quantidade") +
      theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
      theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
      scale_y_continuous(breaks = seq(from = 0, 300, 50)) +
      geom_hline(yintercept = 0, col = "green", lwd = 0.1)
```

```
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Ocorrências" = "Furto de Veículo"
#-------------------------------------------------------------------------------
# TS somente com o Qtd de Evento F_d_V = "Furto de Veículo":

ts_DB_Oco_F_d_V = ts(DB_SSPBA_Oco$F_d_V, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_Oco_F_d_V)
View(ts_DB_Oco_F_d_V)
class(ts_DB_Oco_F_d_V)

ts_DB_Oco_F_d_V
#-------------------------------------------------------------------------------

autoplot(ts_DB_Oco_F_d_V, ts.colour = "goldenrod4", size = 1) +
        theme_bw() +
        labs(title ="Qtd de Furto de Veículo(Ocorrências) Por Ano",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 35, 5)) +
        geom_hline(aes(yintercept = mean(ts_DB_Oco_F_d_V[ts_DB_Oco_F_d_V != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
autoplot(ts_DB_Oco_F_d_V, ts.geom = "point", shape = 3, size = 1.50,
       ts.colour = "goldenrod4") +
        theme_bw() +
        labs(title ="Qtd de Furto de Veículo(Ocorrências) Por Ano",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 35, 5)) +
        geom_hline(aes(yintercept = mean(ts_DB_Oco_F_d_V[ts_DB_Oco_F_d_V != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
ggseasonplot(ts_DB_Oco_F_d_V, polar = T) +
           theme_bw() +
           labs(title ="Qtd de Furto de Veículo(Ocorrências) Por Ano/Mês",
                subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
                x="Meses", y="Quantidade") +
           theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
           theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
           labs(color = "Anos") +
           scale_colour_brewer(palette = "Dark2") +
```

```
          scale_y_continuous(breaks = seq(from = 0, 40, 7)) +
          geom_line(linetype = 3, size = 1.2) +
          geom_point(lwd = 3)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive

add_hw_Oco_F_d_V = HoltWinters(ts_DB_Oco_F_d_V, seasonal = "additive")

add_hw_Oco_F_d_V

prev_add_hw_Oco_F_d_V = forecast(add_hw_Oco_F_d_V, h = 60, level = 80)

prev_add_hw_Oco_F_d_V

autoplot(prev_add_hw_Oco_F_d_V, size = 1, ts.colour = "goldenrod4") +
        theme_bw() +
        labs(title ="Qtd de Furto de Veículo(Ocorrências) com Previsão Aditiva + 5anos",
             subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
             x="Anos", y="Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 40, 7)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - multiplicative

mult_hw_Oco_F_d_V = HoltWinters(ts_DB_Oco_F_d_V, seasonal = "multiplicative")

mult_hw_Oco_F_d_V

prev_mult_hw_Oco_F_d_V = forecast(mult_hw_Oco_F_d_V, h = 60, level = 80)

prev_mult_hw_Oco_F_d_V

autoplot(prev_mult_hw_Oco_F_d_V, size = 1, ts.colour = "goldenrod4") +
        theme_bw() +
        labs(title ="Qtd de Furto de Veículo(Ocorrências) com Previsão Multiplicativa + 5anos",
             subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
             x="Anos", y="Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 2000, 500)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
#*******************************************************************************
#-------------------------------------------------------------------------------
# "Principais Delitos - Quantidade de Ocorrências" = "Uso Porte Substância Entorpecente (Usuários)"
#-------------------------------------------------------------------------------
```

```
# TS somente com o Qtd de Evento U_P_S_E_U = "Uso Porte Substância Entorpecente (Usuários)":

ts_DB_Oco_U_P_S_E_U = ts(DB_SSPBA_Oco$U_P_S_E_U, start = c(2014,1), end = c(2021,6), freq = 12)

str(ts_DB_Oco_U_P_S_E_U)
View(ts_DB_Oco_U_P_S_E_U)
class(ts_DB_Oco_U_P_S_E_U)

ts_DB_Oco_U_P_S_E_U
#-------------------------------------------------------------------------------
autoplot(ts_DB_Oco_U_P_S_E_U, ts.colour = "goldenrod4", size = 1) +
        theme_bw() +
        labs(title ="Qtd de Uso Porte Substância Entorpecente_Usuários(Ocorrências) Por Ano",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 35, 7)) +
        geom_hline(aes(yintercept = mean(ts_DB_Oco_U_P_S_E_U[ts_DB_Oco_U_P_S_E_U != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
autoplot(ts_DB_Oco_U_P_S_E_U, ts.geom = "point", shape = 3, size = 1.50,
       ts.colour = "goldenrod4") +
        theme_bw() +
        labs(title ="Qtd de Uso Porte Substância Entorpecente_Usuários(Ocorrências) Por Ano",
             subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
             x = "Anos", y = "Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 35, 7)) +
        geom_hline(aes(yintercept = mean(ts_DB_Oco_U_P_S_E_U[ts_DB_Oco_U_P_S_E_U != 0])),
                   col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
ggseasonplot(ts_DB_Oco_U_P_S_E_U, polar = T) +
           theme_bw() +
           labs(title ="Qtd de Uso Porte Substância Entorpecente_Usuários(Ocorrências) Por Ano/Mês",
                subtitle = "Salvador/BA - AISP 11 (2014-2021[1ºSem.])",
                x="Meses", y="Quantidade") +
           theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
           theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
           labs(color = "Anos") +
           scale_colour_brewer(palette = "Dark2") +
           scale_y_continuous(breaks = seq(from = 0, 35, 7)) +
           geom_line(linetype = 3, size = 1.2) +
           geom_point(lwd = 3)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - additive
```

```
add_hw_Oco_U_P_S_E_U = HoltWinters(ts_DB_Oco_U_P_S_E_U, seasonal = "additive")

add_hw_Oco_U_P_S_E_U

prev_add_hw_Oco_U_P_S_E_U = forecast(add_hw_Oco_U_P_S_E_U, h = 60, level = 80)

prev_add_hw_Oco_U_P_S_E_U

autoplot(prev_add_hw_Oco_U_P_S_E_U, size = 1, ts.colour = "goldenrod4") +
        theme_bw() +
        labs(title ="Qtd de Uso Porte Substância Entorpecente_Usuários(Ocorrências) com Previsão Aditiva + 5anos",
             subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
             x="Anos", y="Quantidade") +
        theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
        theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
        scale_y_continuous(breaks = seq(from = 0, 50, 10)) +
        geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
# Forecasting - HoltWinters - multiplicative

# mult_hw_Oco_U_P_S_E_U = HoltWinters(ts_DB_Oco_U_P_S_E_U, seasonal = "multiplicative")
#
# mult_hw_Oco_U_P_S_E_U
#
# prev_mult_hw_Oco_U_P_S_E_U = forecast(mult_hw_Oco_U_P_S_E_U, h = 60, level = 80)
#
# prev_mult_hw_Oco_U_P_S_E_U
#
# autoplot(prev_mult_hw_Oco_U_P_S_E_U, size = 1, ts.colour = "goldenrod4") +
#          theme_bw() +
#         labs(title ="Qtd de Uso Porte Substância Entorpecente_Usuários(Ocorrências) com Previsão Aditiva + 5anos",
#              subtitle = "Salvador/BA - AISP 11 (2014-2026[1ºSem.])",
#              x="Anos", y="Quantidade") +
#          theme(plot.title = element_text(family = "Times", hjust = 0.5)) +
#          theme(plot.subtitle = element_text(family = "Times", hjust = 0.5)) +
#          scale_y_continuous(breaks = seq(from = 0, 50, 7)) +
#          geom_hline(yintercept = 0, col = "green", lwd = 0.1)
#-------------------------------------------------------------------------------
#*******************************************************************************
```