**analise.R**

**library**(tidyverse)

## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──  
## ✔ dplyr 1.1.3 ✔ readr 2.1.4  
## ✔ forcats 1.0.0 ✔ stringr 1.5.0  
## ✔ ggplot2 3.4.1 ✔ tibble 3.2.1  
## ✔ lubridate 1.9.3 ✔ tidyr 1.3.0  
## ✔ purrr 1.0.1   
## ── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::lag() masks stats::lag()  
## ℹ Use the conflicted package (<<http://conflicted.r-lib.org/>>) to force all conflicts to become errors

**library**(forecast)

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

**library**(lubridate)  
**library**(data.table)

##   
## Attaching package: 'data.table'  
##   
## The following objects are masked from 'package:lubridate':  
##   
## hour, isoweek, mday, minute, month, quarter, second, wday, week,  
## yday, year  
##   
## The following objects are masked from 'package:dplyr':  
##   
## between, first, last  
##   
## The following object is masked from 'package:purrr':  
##   
## transpose

*# ITAIPU*  
  
base <- **fread**(input = **paste0**("itaipu\_mensal\_oficial.csv"), header = T, na.strings = "NA", data.table = FALSE, dec=",")   
  
base**$**tempo <- **seq**(1**:nrow**(base))  
base**$**intervalo <- **as.factor**(base**$**mes)  
base**$**afluencia <- **as.numeric**(base**$**afluencia)  
  
*# Visualização gráfica*  
**plot**(base**$**tempo,base**$**afluencia,xlab="Período de Tempo", ylab="Afluência")  
**lines**(base**$**tempo,base**$**afluencia, col = "black")



*# SUAVIZACAO EXPONENCIAL SIMPLES (SES) ########################################*  
alpha1 <- **ses**(base**$**afluencia, alpha = 0.1)  
alpha2 <- **ses**(base**$**afluencia, alpha = 0.5)  
alpha3 <- **ses**(base**$**afluencia, alpha = 0.9)  
  
*#calculo dos erros de cada ajuste*  
itaipu\_resultados\_SES <- **list**(alpha1, alpha2, alpha3) **%>%** **map**(accuracy)  
  
itaipu\_tabela\_SES <- **do.call**(rbind, **lapply**(**seq\_along**(itaipu\_resultados\_SES), **function**(i) {  
 **data.frame**(Modelo = **paste**("Modelo", i), itaipu\_resultados\_SES[[i]])  
}))  
**rownames**(itaipu\_tabela\_SES) <- **c**("alpha1", "alpha2", "alpha3")  
  
*#gráfico do ajuste*  
**plot**(base**$**afluencia,type="s")  
**lines**(**fitted**(alpha1), col="blue")  
**lines**(**fitted**(alpha2), col="red")  
**lines**(**fitted**(alpha3), col="green")  
**legend**("topleft",lty=1, col=**c**(1,"blue","red","green"),  
 **c**("serie original",  
 **expression**(alpha **==** 0.1),  
 **expression**(alpha **==** 0.5),  
 **expression**(alpha **==** 0.9)),  
 pch=1)



alpha\_otimo <- **ses**(base**$**afluencia)  
**summary**(alpha\_otimo)

##   
## Forecast method: Simple exponential smoothing  
##   
## Model Information:  
## Simple exponential smoothing   
##   
## Call:  
## ses(y = base$afluencia)   
##   
## Smoothing parameters:  
## alpha = 0.8332   
##   
## Initial states:  
## l = 9718.8769   
##   
## sigma: 1931.325  
##   
## AIC AICc BIC   
## 5492.581 5492.673 5503.320   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE ACF1  
## Training set -18.0542 1924.024 1375.915 -1.723872 12.30088 0.9830167 0.02194365  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 266 5732.532 3257.4385 8207.625 1947.2034 9517.86  
## 267 5732.532 2510.8891 8954.174 805.4546 10659.61  
## 268 5732.532 1907.3682 9557.695 -117.5510 11582.61  
## 269 5732.532 1386.8706 10078.193 -913.5834 12378.65  
## 270 5732.532 922.3690 10542.694 -1623.9772 13089.04  
## 271 5732.532 498.9326 10966.131 -2271.5673 13736.63  
## 272 5732.532 107.2802 11357.783 -2870.5480 14335.61  
## 273 5732.532 -258.8245 11723.888 -3430.4568 14895.52  
## 274 5732.532 -603.8114 12068.875 -3958.0687 15423.13  
## 275 5732.532 -930.9612 12396.024 -4458.4012 15923.46

*# alpha = 0.8332*   
  
*# SUAVIZACAO EXPONENCIAL DE HOLT ##############################################*  
beta1 <- **holt**(base**$**afluencia, alpha = 0.6, beta = 0.4)  
**summary**(beta1)

##   
## Forecast method: Holt's method  
##   
## Model Information:  
## Holt's method   
##   
## Call:  
## holt(y = base$afluencia, alpha = 0.6, beta = 0.4)   
##   
## Smoothing parameters:  
## alpha = 0.6   
## beta = 0.4   
##   
## Initial states:  
## l = 9989.6635   
## b = 286.0696   
##   
## sigma: 2353.962  
##   
## AIC AICc BIC   
## 5595.441 5595.533 5606.180   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE ACF1  
## Training set -10.97036 2336.129 1701.424 -0.7181872 15.66191 1.215575 0.153274  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 266 5246.76680 2230.0432 8263.490 633.0861 9860.447  
## 267 4369.97777 103.6863 8636.269 -2154.7520 10894.708  
## 268 3493.18875 -2510.0155 9496.393 -5687.9199 12674.297  
## 269 2616.39972 -5478.3192 10711.119 -9763.4046 14996.204  
## 270 1739.61069 -8728.0291 12207.250 -14269.2629 17748.484  
## 271 862.82166 -12217.3804 13943.024 -19141.6210 20867.264  
## 272 -13.96737 -15919.8555 15891.921 -24339.9241 24311.989  
## 273 -890.75640 -19816.9410 18035.428 -29835.8579 28054.345  
## 274 -1767.54543 -23894.7558 20359.665 -35608.1934 32073.103  
## 275 -2644.33445 -28142.3423 22853.673 -41640.1722 36351.503

beta2 <- **holt**(base**$**afluencia)  
**summary**(beta2)

##   
## Forecast method: Holt's method  
##   
## Model Information:  
## Holt's method   
##   
## Call:  
## holt(y = base$afluencia)   
##   
## Smoothing parameters:  
## alpha = 0.8407   
## beta = 0.0043   
##   
## Initial states:  
## l = 10515.9894   
## b = 193.3977   
##   
## sigma: 1949.47  
##   
## AIC AICc BIC   
## 5499.514 5499.745 5517.412   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE  
## Training set -147.2325 1934.701 1393.986 -2.946394 12.56387 0.9959275  
## ACF1  
## Training set 0.01476812  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 266 5754.676 3256.32997 8253.023 1933.7852 9575.568  
## 267 5779.206 2508.25650 9050.155 776.7206 10781.691  
## 268 5803.735 1904.72766 9702.742 -159.2820 11766.752  
## 269 5828.264 1384.00763 10272.520 -968.6395 12625.167  
## 270 5852.793 918.54393 10787.042 -1693.4898 13399.076  
## 271 5877.322 493.20743 11261.437 -2356.9708 14111.615  
## 272 5901.851 98.63843 11705.064 -2973.3969 14777.100  
## 273 5926.380 -271.42662 12124.188 -3552.3475 15405.108  
## 274 5950.910 -621.42057 12523.240 -4100.6020 16002.421  
## 275 5975.439 -954.61519 12905.493 -4623.1642 16574.042

*# beta1 = 0.4*  
*# beta = 0.0043*   
  
*#calculo dos erros de cada ajuste*  
itaipu\_resultados\_holt <- **list**(beta1, beta2) **%>%** **map**(accuracy)  
  
itaipu\_tabela\_holt <- **do.call**(rbind, **lapply**(**seq\_along**(itaipu\_resultados\_holt), **function**(i) {  
 **data.frame**(Modelo = **paste**("Modelo", i), itaipu\_resultados\_holt[[i]])  
}))  
**rownames**(itaipu\_tabela\_holt) <- **c**("beta1", "beta2")  
  
*#gráfico do ajuste*  
**plot**(base**$**afluencia,type="s", ylim = **c**(0, 25000))  
**lines**(**fitted**(beta1), col = "blue")  
**lines**(**fitted**(beta2), col = "red")  
**legend**("topleft", lty = 1, col = **c**(1, "blue", "red"),  
 legend = **c**("Série Original", "beta1", "beta2"),  
 pch = 1)



*# SUAVIZACAO EXPONENCIAL DE HOLT-WINTER #######################################*  
base\_ts <- **ts**(base**$**afluencia, frequency=12, start=**c**(1980,1))  
base\_ts

## Jan Feb Mar Apr May Jun Jul  
## 1980 9505.871 10722.276 11403.097 9936.600 9379.290 9908.633 10409.613  
## 1981 11947.387 13432.857 9947.452 10361.333 9204.355 8324.033 7207.452  
## 1982 10846.419 13322.393 12020.290 9694.233 11422.516 8662.400 7923.774  
## 1983 10008.806 14495.357 12500.871 11315.867 9444.548 9103.033 9020.387  
## 1984 9065.677 9274.345 9947.613 9876.200 11526.290 12018.933 10997.387  
## 1985 14932.387 15507.607 9985.710 10223.067 9604.806 9844.100 8709.097  
## 1986 11914.839 11008.071 13678.548 12535.967 9496.387 10003.200 9769.065  
## 1987 16825.834 21894.548 15253.702 11077.402 10352.178 9275.790 9841.009  
## 1988 10082.396 10076.140 11967.382 12864.504 11022.488 10759.533 9814.690  
## 1989 9791.832 11531.235 11202.948 10821.955 9461.495 9699.214 11210.389  
## 1990 22356.948 20382.784 14233.089 15341.942 11509.636 10176.839 10105.635  
## 1991 12560.671 14675.388 19424.982 15448.052 10827.973 10382.394 11335.058  
## 1992 12081.456 11033.137 10994.075 11200.670 10961.088 14918.787 12056.935  
## 1993 10497.979 12554.527 12882.475 11895.324 10430.807 15115.308 14486.794  
## 1994 11140.852 10674.360 10810.633 10791.888 9657.476 12587.324 9046.249  
## 1995 9984.706 10545.801 10351.057 9397.109 9117.649 8740.439 13171.730  
## 1996 20319.835 15516.441 18162.568 11759.566 12420.527 15110.524 11236.243  
## 1997 11806.452 12037.111 11120.533 10004.505 11141.226 12777.621 8875.401  
## 1998 16830.785 12533.727 13928.755 11262.582 8927.947 8311.235 7773.581  
## 1999 10391.561 9186.739 10263.199 8614.319 8440.668 8775.478 7320.028  
## 2000 9875.186 9479.321 8302.685 7365.502 6899.244 6967.628 6986.034  
## 2001 9232.826 9935.652 7688.881 6238.021 5845.759 5713.713 4688.531  
## 2002 5589.512   
## Aug Sep Oct Nov Dec  
## 1980 10086.323 13444.000 11447.613 10755.367 10787.742  
## 1981 6767.710 7027.967 8255.774 7950.667 8732.613  
## 1982 8419.032 8851.533 9256.516 9064.000 10934.968  
## 1983 8931.710 9510.400 10665.935 9938.900 11369.903  
## 1984 9205.290 9374.933 11163.871 12022.833 10745.839  
## 1985 8821.645 9315.533 12991.161 10678.667 12446.903  
## 1986 9603.484 10258.479 9575.806 10003.431 11384.177  
## 1987 9401.214 9367.673 9401.236 9764.156 10027.740  
## 1988 12128.665 9421.470 10566.604 10802.473 8125.121  
## 1989 10320.347 13000.994 15771.712 14260.631 18783.704  
## 1990 9427.588 9578.053 11239.367 10595.046 12367.187  
## 1991 13363.768 10242.812 11389.413 11977.760 11290.709  
## 1992 10550.506 9809.226 10064.204 9703.310 10212.908  
## 1993 10055.182 9888.325 10904.961 9909.742 10534.878  
## 1994 8252.758 9064.045 9541.569 9448.044 9248.261  
## 1995 8225.973 8980.790 12217.819 15262.546 17985.169  
## 1996 11977.205 10901.427 11739.602 10439.929 11647.377  
## 1997 9227.611 9132.782 10953.261 12097.701 13138.624  
## 1998 9183.271 8708.860 11939.883 11791.102 9884.999  
## 1999 7408.461 8529.145 8033.097 7346.908 10047.218  
## 2000 8184.143 7808.492 8509.971 7813.352 7599.960  
## 2001 4973.714 6982.994 8773.112 7132.700 6266.761  
## 2002

gama\_ad <- **hw**(base\_ts, seasonal = "additive")  
gama\_mult <- **hw**(base\_ts, seasonal = "multiplicative")  
  
*# calculando o erro de cada ajuste*  
itaipu\_tabela\_holtwinter <- **list**(gama\_ad, gama\_mult) **%>%** **map**(accuracy)  
  
itaipu\_tabela\_holtwinter <- **do.call**(rbind, **lapply**(**seq\_along**(itaipu\_tabela\_holtwinter), **function**(i) {  
 **data.frame**(Modelo = **paste**("Modelo", i), itaipu\_tabela\_holtwinter[[i]])  
}))  
**rownames**(itaipu\_tabela\_holtwinter) <- **c**("gama\_ad", "gama\_mult")  
  
*# analise grafica do ajuste*  
**plot**(base\_ts, , ylim = **c**(0, 25000))  
**lines**(**fitted**(gama\_ad), col = "blue")  
**lines**(**fitted**(gama\_mult), col = "red")  
**legend**("topleft", lty = 1, col = **c**(1, "blue", "red"),  
 legend = **c**("Série Original", "gama\_ad", "gama\_mult"),  
 pch = 1)



*# COMPARACAO GERAL ITAIPU ######################################################*  
  
itaipu\_tabela\_geral <- **list**(alpha\_otimo, beta2, gama\_ad) **%>%** **map**(accuracy)  
  
itaipu\_tabela\_geral <- **do.call**(rbind, **lapply**(**seq\_along**(itaipu\_tabela\_geral), **function**(i) {  
 **data.frame**(Modelo = **paste**("Modelo", i), itaipu\_tabela\_geral[[i]])  
}))  
**rownames**(itaipu\_tabela\_geral) <- **c**("alpha\_otimo", "beta2", "gama\_ad")  
  
*# SOBRADINHO*  
  
base <- **fread**(input = **paste0**("sobradinho\_mensal\_oficial.csv"), header = T, na.strings = "NA", data.table = FALSE, dec=",")   
  
base**$**tempo <- **seq**(1**:nrow**(base))  
base**$**intervalo <- **as.factor**(base**$**mes)  
base**$**afluencia <- **as.numeric**(base**$**afluencia)  
  
*# Visualização gráfica*  
**plot**(base**$**tempo,base**$**afluencia,xlab="Período de Tempo", ylab="Afluência")  
**lines**(base**$**tempo,base**$**afluencia, col = "black")



*# SUAVIZACAO EXPONENCIAL SIMPLES (SES) ########################################*  
alpha1 <- **ses**(base**$**afluencia, alpha = 0.1)  
alpha2 <- **ses**(base**$**afluencia, alpha = 0.5)  
alpha3 <- **ses**(base**$**afluencia, alpha = 0.9)  
  
*#calculo dos erros de cada ajuste*  
sobradinho\_resultados\_SES <- **list**(alpha1, alpha2, alpha3) **%>%** **map**(accuracy)  
  
sobradinho\_tabela\_SES <- **do.call**(rbind, **lapply**(**seq\_along**(sobradinho\_resultados\_SES), **function**(i) {  
 **data.frame**(Modelo = **paste**("Modelo", i), sobradinho\_resultados\_SES[[i]])  
}))  
**rownames**(sobradinho\_tabela\_SES) <- **c**("alpha1", "alpha2", "alpha3")  
  
*#gráfico do ajuste*  
**plot**(base**$**afluencia,type="s")  
**lines**(**fitted**(alpha1), col="blue")  
**lines**(**fitted**(alpha2), col="red")  
**lines**(**fitted**(alpha3), col="green")  
**legend**("topleft",lty=1, col=**c**(1,"blue","red","green"),  
 **c**("serie original",  
 **expression**(alpha **==** 0.1),  
 **expression**(alpha **==** 0.5),  
 **expression**(alpha **==** 0.9)),  
 pch=1)



alpha\_otimo <- **ses**(base**$**afluencia)  
**summary**(alpha\_otimo)

##   
## Forecast method: Simple exponential smoothing  
##   
## Model Information:  
## Simple exponential smoothing   
##   
## Call:  
## ses(y = base$afluencia)   
##   
## Smoothing parameters:  
## alpha = 0.9999   
##   
## Initial states:  
## l = 2283.6777   
##   
## sigma: 797.7704  
##   
## AIC AICc BIC   
## 5023.986 5024.078 5034.725   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE ACF1  
## Training set 6.912394 794.7543 521.2758 -7.912437 31.65711 1.005385 0.1856043  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 266 4115.279 3092.8951 5137.663 2551.67772 5678.880  
## 267 4115.279 2669.4821 5561.076 1904.12342 6326.435  
## 268 4115.279 2344.5762 5885.982 1407.22268 6823.335  
## 269 4115.279 2070.6645 6159.894 988.31097 7242.247  
## 270 4115.279 1829.3419 6401.216 619.23994 7611.318  
## 271 4115.279 1611.1688 6619.389 285.57286 7944.985  
## 272 4115.279 1410.5372 6820.021 -21.26656 8251.825  
## 273 4115.279 1223.7936 7006.764 -306.86632 8537.424  
## 274 4115.279 1048.3999 7182.158 -575.10790 8805.666  
## 275 4115.279 882.5081 7348.050 -828.81741 9059.375

*# alpha = 0.9999*   
  
*# SUAVIZACAO EXPONENCIAL DE HOLT ##############################################*  
beta1 <- **holt**(base**$**afluencia, alpha = 0.6, beta = 0.4)  
**summary**(beta1)

##   
## Forecast method: Holt's method  
##   
## Model Information:  
## Holt's method   
##   
## Call:  
## holt(y = base$afluencia, alpha = 0.6, beta = 0.4)   
##   
## Smoothing parameters:  
## alpha = 0.6   
## beta = 0.4   
##   
## Initial states:  
## l = 4284.693   
## b = -302.6462   
##   
## sigma: 1033.234  
##   
## AIC AICc BIC   
## 5159.036 5159.128 5169.775   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE ACF1  
## Training set 15.27376 1025.407 734.8264 8.257265 54.43748 1.417261 0.3940861  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 266 4871.620 3547.477 6195.763 2846.5182 6896.722  
## 267 6187.993 4315.372 8060.614 3324.0661 9051.919  
## 268 7504.365 4869.354 10139.377 3474.4632 11534.267  
## 269 8820.738 5267.689 12373.786 3386.8190 14254.657  
## 270 10137.110 5542.506 14731.715 3110.2692 17163.952  
## 271 11453.483 5712.136 17194.830 2672.8500 20234.116  
## 272 12769.855 5788.218 19751.493 2092.3625 23447.348  
## 273 14086.228 5778.879 22393.577 1381.2347 26791.221  
## 274 15402.601 5690.212 25114.989 548.7848 30256.416  
## 275 16718.973 5527.027 27910.919 -397.6315 33835.578

beta2 <- **holt**(base**$**afluencia)  
**summary**(beta2)

##   
## Forecast method: Holt's method  
##   
## Model Information:  
## Holt's method   
##   
## Call:  
## holt(y = base$afluencia)   
##   
## Smoothing parameters:  
## alpha = 0.9999   
## beta = 0.007   
##   
## Initial states:  
## l = 3990.4784   
## b = -121.2353   
##   
## sigma: 802.2038  
##   
## AIC AICc BIC   
## 5028.900 5029.132 5046.799   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE ACF1  
## Training set 63.86008 796.1264 522.2182 -2.328062 31.18327 1.007203 0.1831915  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 266 4112.794 3084.7282 5140.859 2540.5032 5685.084  
## 267 4110.310 2651.3686 5569.251 1879.0517 6341.568  
## 268 4107.826 2314.7594 5900.893 1365.5671 6850.085  
## 269 4105.342 2027.6611 6183.024 927.8031 7282.882  
## 270 4102.859 1771.8446 6433.873 537.8803 7667.837  
## 271 4100.375 1537.9945 6662.755 181.5522 8019.198  
## 272 4097.891 1320.5967 6875.186 -149.6143 8345.397  
## 273 4095.407 1116.0712 7074.744 -461.0942 8651.909  
## 274 4092.924 921.9401 7263.907 -756.6771 8942.525  
## 275 4090.440 736.4058 7444.474 -1039.1127 9219.993

*# beta1 = 0.4*  
*# beta = 0.007*  
  
*#calculo dos erros de cada ajuste*  
sobradinho\_resultados\_holt <- **list**(beta1, beta2) **%>%** **map**(accuracy)  
  
sobradinho\_tabela\_holt <- **do.call**(rbind, **lapply**(**seq\_along**(sobradinho\_resultados\_holt), **function**(i) {  
 **data.frame**(Modelo = **paste**("Modelo", i), sobradinho\_resultados\_holt[[i]])  
}))  
**rownames**(sobradinho\_tabela\_holt) <- **c**("beta1", "beta2")  
  
*#gráfico do ajuste*  
**plot**(base**$**afluencia,type="s", ylim = **c**(**-**1000, 8000))  
**lines**(**fitted**(beta1), col = "blue")  
**lines**(**fitted**(beta2), col = "red")  
**legend**("topleft", lty = 1, col = **c**(1, "blue", "red"),  
 legend = **c**("Série Original", "beta1", "beta2"),  
 pch = 1)



*# SUAVIZACAO EXPONENCIAL DE HOLT-WINTER #######################################*  
base\_ts <- **ts**(base**$**afluencia, frequency=12, start=**c**(1980,1))  
base\_ts

## Jan Feb Mar Apr May Jun Jul  
## 1980 3536.4516 3843.7931 3309.5806 2737.6667 1594.8387 1260.3333 1197.0968  
## 1981 2600.9677 1561.0714 1673.5484 1154.8333 929.5161 852.5000 654.8387  
## 1982 3409.3548 3444.3214 2318.6774 1752.0333 904.9355 871.0333 921.2258  
## 1983 3353.0968 3404.6429 2343.2258 2364.3333 1322.9032 1046.3333 950.0000  
## 1984 2824.5161 3997.9310 4933.2258 4061.3333 2069.3548 1201.6667 1120.6452  
## 1985 3257.3548 4344.5000 4281.6774 3435.6667 1728.5161 1247.2667 1103.8387  
## 1986 3959.4839 2021.9286 2960.9032 3443.6000 1892.6129 1210.3333 1031.9677  
## 1987 5209.7419 6333.5000 6352.2903 2225.6333 1303.6129 1270.7667 977.0645  
## 1988 2028.5806 2859.3448 3163.5484 2865.0000 1425.4194 1028.4000 870.9677  
## 1989 4113.5484 4280.0000 2956.1290 3859.0000 2098.0645 1393.3333 1082.2581  
## 1990 2765.4839 1802.1429 2234.5161 2331.3333 1327.0968 1107.6667 799.0323  
## 1991 3465.8065 2244.2857 3307.4194 4339.0000 1649.3548 1267.0000 1085.1613  
## 1992 4662.2581 4681.0345 1835.4839 1748.6667 1162.9032 1210.9333 958.4839  
## 1993 1635.9032 2740.3571 1435.3226 2458.0000 1331.6129 1067.3333 880.8710  
## 1994 3046.7742 1425.0000 1342.5806 1569.6667 815.1613 560.0000 568.0645  
## 1995 895.4839 1094.2857 1237.0968 1386.0000 1086.7742 742.6667 616.1290  
## 1996 1711.2903 3202.7586 1139.0323 636.3333 465.8065 400.0000 371.6129  
## 1997 805.1613 1142.5000 938.0645 811.6667 447.7419 484.3333 399.0323  
## 1998 1114.8629 1572.3321 1778.1094 1279.3907 504.9145 430.5653 400.2294  
## 1999 1165.6510 854.7500 1291.2903 1474.6667 872.5806 684.6667 643.2258  
## 2000 1261.2903 3039.3103 3854.8387 3391.3333 1803.2258 946.8333 780.6452  
## 2001 1676.1290 1522.8571 2470.9677 1140.6667 773.2258 620.6667 528.3871  
## 2002 4115.4545   
## Aug Sep Oct Nov Dec  
## 1980 1120.3226 1143.6667 1026.1290 2030.0000 3347.4194  
## 1981 628.7097 628.6667 709.0323 1134.0000 1827.4194  
## 1982 771.7097 777.5000 977.0323 1197.5667 1801.8065  
## 1983 842.9032 764.0000 720.3226 1005.6667 1359.0323  
## 1984 970.3226 940.0000 1023.5484 1120.3333 1806.7742  
## 1985 962.5161 968.0000 1021.9355 1323.0667 3997.1935  
## 1986 1046.5806 963.2667 1263.5484 2517.0667 3340.8065  
## 1987 996.2581 823.6667 751.7742 954.1667 1831.6129  
## 1988 853.0968 749.1333 953.0968 1134.7000 2256.1290  
## 1989 1146.1290 1130.6667 1527.4194 2438.6667 2325.8065  
## 1990 720.3226 766.3333 802.2581 1450.3333 2494.8387  
## 1991 947.7419 968.3333 1163.5484 1352.0000 3055.1613  
## 1992 859.2903 881.3000 967.7097 1786.3333 2079.7742  
## 1993 824.3226 702.7333 734.1613 980.4667 2428.0000  
## 1994 399.6774 366.3333 234.1935 601.0000 1682.2581  
## 1995 529.3548 486.0000 482.9032 587.3333 1046.1290  
## 1996 397.7419 402.0000 497.4194 638.0000 1516.7742  
## 1997 368.3871 317.6667 314.8387 531.6667 1339.0323  
## 1998 385.0590 341.4333 393.0268 943.1093 1908.6697  
## 1999 561.9355 485.0000 446.1290 480.3333 1187.4516  
## 2000 773.2258 741.3333 858.0645 1653.6667 1406.7742  
## 2001 492.2581 502.0000 615.8065 1264.0000 2360.3226  
## 2002

gama\_ad <- **hw**(base\_ts, seasonal = "additive")  
gama\_mult <- **hw**(base\_ts, seasonal = "multiplicative")  
  
*# calculando o erro de cada ajuste*  
sobradinho\_tabela\_holtwinter <- **list**(gama\_ad, gama\_mult) **%>%** **map**(accuracy)  
  
sobradinho\_tabela\_holtwinter <- **do.call**(rbind, **lapply**(**seq\_along**(sobradinho\_tabela\_holtwinter), **function**(i) {  
 **data.frame**(Modelo = **paste**("Modelo", i), sobradinho\_tabela\_holtwinter[[i]])  
}))  
**rownames**(sobradinho\_tabela\_holtwinter) <- **c**("gama\_ad", "gama\_mult")  
  
*# analise grafica do ajuste*  
**plot**(base\_ts, , ylim = **c**(0, 7000))  
**lines**(**fitted**(gama\_ad), col = "blue")  
**lines**(**fitted**(gama\_mult), col = "red")  
**legend**("topleft", lty = 1, col = **c**(1, "blue", "red"),  
 legend = **c**("Série Original", "gama\_ad", "gama\_mult"),  
 pch = 1)



*# COMPARACAO GERAL SOBRADINHO ##################################################*  
  
sobradinho\_tabela\_geral <- **list**(alpha\_otimo, beta2, gama\_mult) **%>%** **map**(accuracy)  
  
sobradinho\_tabela\_geral <- **do.call**(rbind, **lapply**(**seq\_along**(sobradinho\_tabela\_geral), **function**(i) {  
 **data.frame**(Modelo = **paste**("Modelo", i), sobradinho\_tabela\_geral[[i]])  
}))  
**rownames**(sobradinho\_tabela\_geral) <- **c**("alpha\_otimo", "beta2", "gama\_mult")