Temporal hierarchies

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1. Data and packages

```r
pckg <- c("thief","MAPA","tsutils","abind")
for (i in 1:length(pckg)){
if(!(pckg[i] %in% rownames(installed.packages()))){
install.packages(pckg[i])
}
library(pckg[i],character.only = TRUE)
}
```

```
## Warning: package 'thief' was built under R version 4.2.3
```

```
## Loading required package: forecast
```

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

```
## Loading required package: parallel
```

```
## Loading required package: RColorBrewer
```

```
## Loading required package: smooth
```

```
## Loading required package: greybox
```

```
## Package "greybox", v1.0.5 loaded.
```

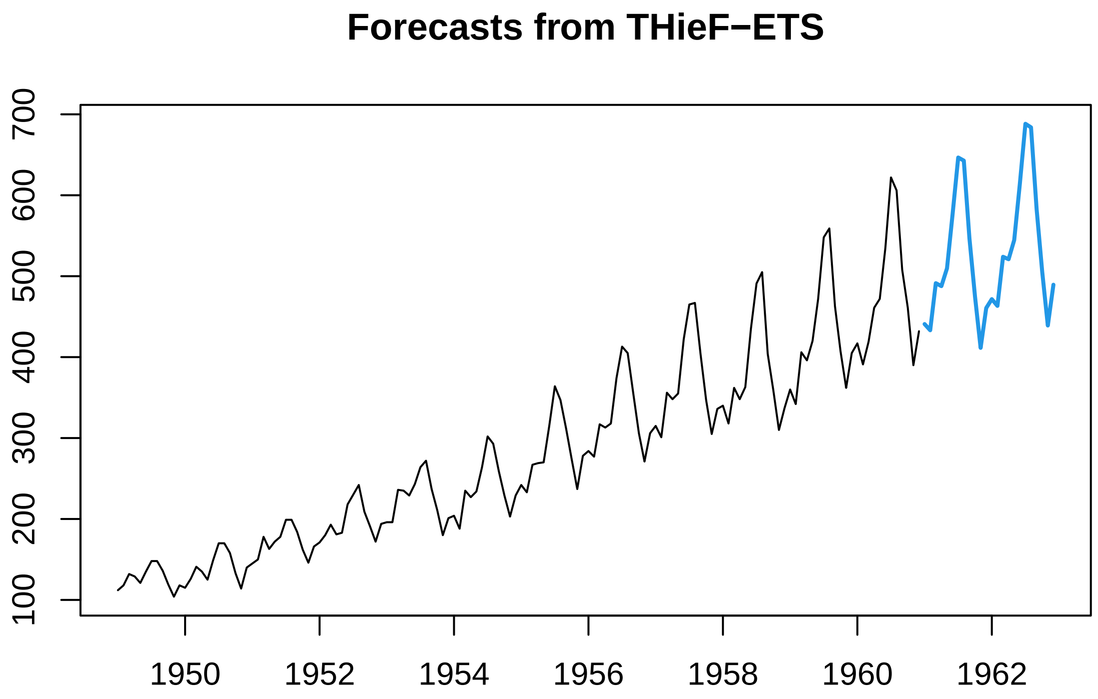
```
## This is package "smooth", v3.1.6
```

```
## Warning: package 'tsutils' was built under R version 4.2.3
```

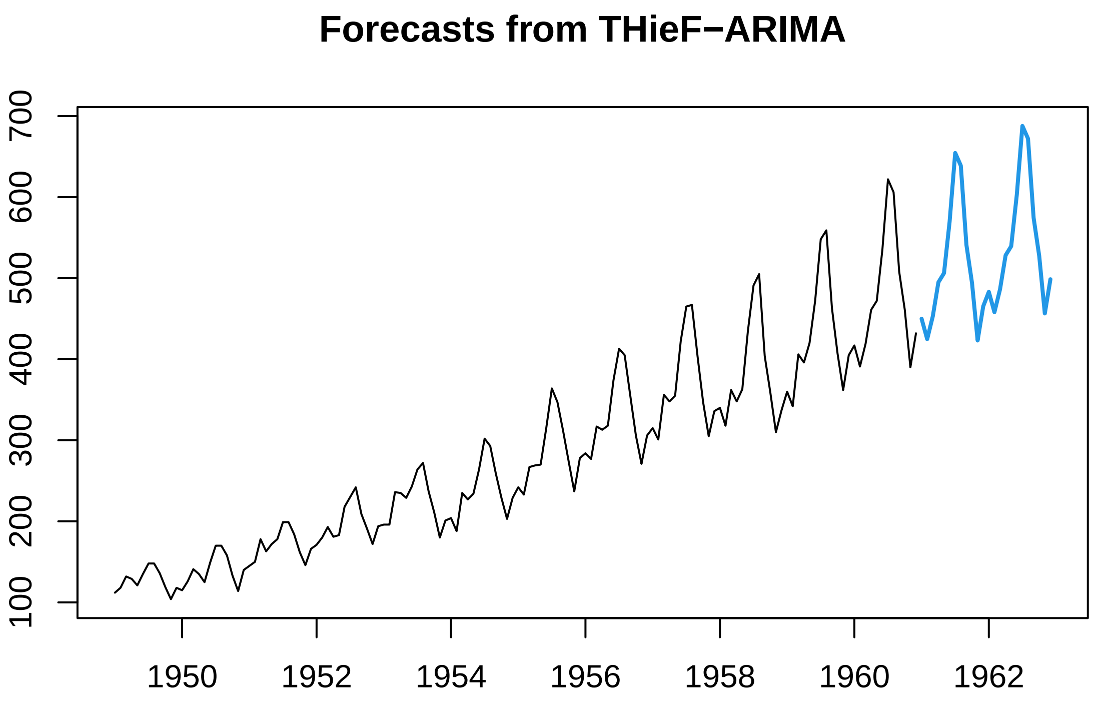
```r
y <- AirPassengers
```

2. Temporal hierarchies using the thief package

```r
frc1 <- thief(y)
plot(frc1)
```



```r
frc2 <- thief(y,usemodel="arima")
plot(frc2)
```



3. Manual implementation of THieF

```
S <- tsutils::Sthief(y) # Get the S matrix
ff <- frequency(y) # Get sampling frequency of target series
AL <- ff/(1:ff) # Calculate frequencies of various aggregation levels
AL <- AL[AL %% 1 == 0] # And exclude those that would not be integer
k <- length(AL) # Find how many are left
```

```
Y <- MAPA::tsaggr(y,AL)[[1]]
```

```
hrz <- 16 # Target horizon
hAggr <- (ceiling(hrz/ff)*ff)/AL
hAggr
```

```
## [1]  2  4  6  8 12 24
```

```
frc <- mse <- list()
for (i in 1:k){
yTemp <- Y[[i]]
fit <- ets(yTemp)
mse[[i]] <- fit$mse
frcTemp <- forecast(fit,h=hAggr[i])$mean
```

```r
# Re-structure forecasts
frc[[i]] <- matrix(frcTemp,ncol=hAggr[1]) # Organised as column per year
}
```

```r
frcAll <- abind(frc,along=1)
frcAll
```

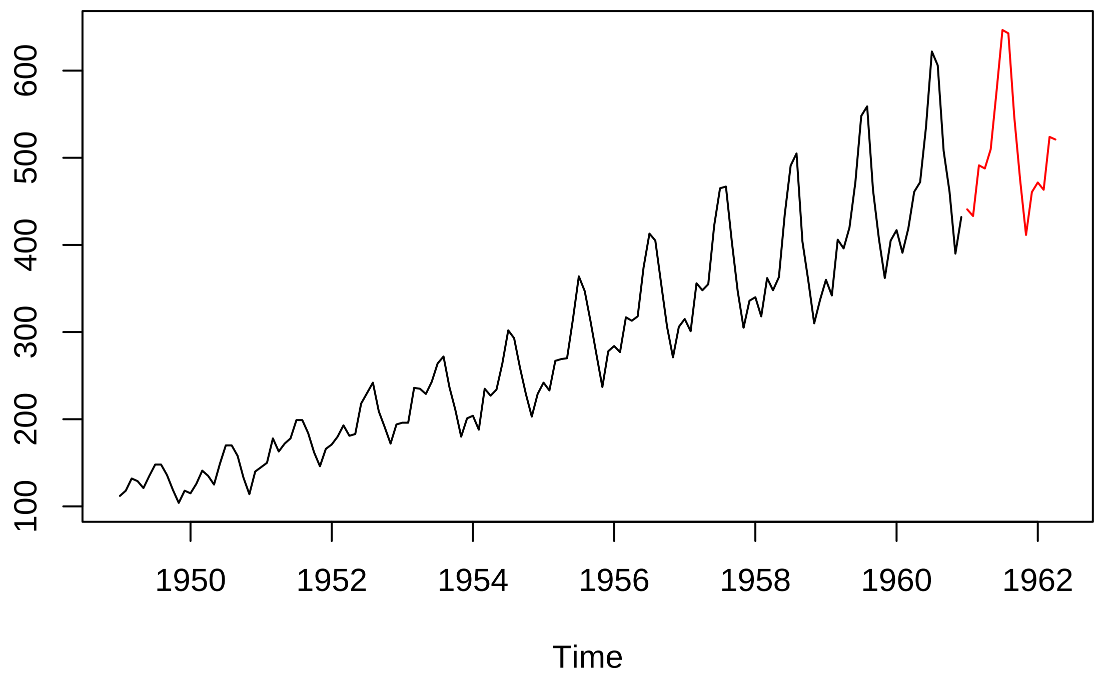
```
##              [,1]      [,2]
##  [1,] 6117.6361 6596.1292
##  [2,] 3007.6633 3250.5458
##  [3,] 3129.1045 3371.9871
##  [4,] 1833.0574 1941.5106
##  [5,] 2393.3701 2532.2736
##  [6,] 1898.4091 2006.5253
##  [7,] 1355.3595 1459.7158
##  [8,] 1593.3745 1713.7677
##  [9,] 1887.3399 2027.3332
## [10,] 1383.1478 1483.8981
## [11,]  867.1471  929.9355
## [12,]  963.5666 1032.5139
## [13,] 1094.7423 1172.1632
## [14,] 1332.7008 1425.8650
## [15,] 1037.7271 1109.4450
## [16,]  881.9057  942.1689
## [17,]  441.8018  459.0139
## [18,]  434.1186  450.6333
## [19,]  496.6300  515.0797
## [20,]  483.2375  500.7700
## [21,]  483.9914  501.1423
## [22,]  551.0244  570.0974
## [23,]  613.1797  633.9130
## [24,]  609.3648  629.4938
## [25,]  530.5408  547.6630
## [26,]  463.0332  477.6340
## [27,]  402.7478  415.1573
## [28,]  451.9694  465.5780
```

```r
# Structural:
W <- diag(1/rowSums(S))
Gstr <- solve(t(S)%*%W%*%S)%*%t(S)%*%W
# Variance:
mse <- unlist(mse)
W <- diag(1/mse[rep((1:k),rev(AL))])
Gvar <- solve(t(S)%*%W%*%S)%*%t(S)%*%W
```

```r
# Create the bottom level forecasts
frcBRec <- Gstr %*% frcAll
frcFinal <- as.numeric(frcBRec)[1:hrz]
# We can also translate this into a time series object
frcFinal <- ts(frcFinal,frequency=frequency(y),start=end(y)[1] + deltat(y)*end(y)[2])
frcFinal
```

```
##             Jan       Feb       Mar       Apr       May       Jun       Jul       Aug
## 1961 440.8650 433.1818 491.3771 487.7213 509.7371 576.7701 646.6260 642.8111
## 1962 471.6625 463.2819 524.0035 520.9690
##           Sep      Oct      Nov      Dec
## 1961 547.0800 474.7431 411.4239 460.6455
## 1962
```

```
ts.plot(y,frcFinal,col=c("black","red"))
```



```
frcARec <- S %*% frcBRec
```

```
frcARec
```

```
##              [,1]      [,2]
##  [1,] 6122.9819 6526.9923
##  [2,] 2939.6523 3138.1222
##  [3,] 3183.3296 3388.8700
##  [4,] 1853.1451 1979.9169
##  [5,] 2375.9443 2530.3770
##  [6,] 1893.8925 2016.6984
##  [7,] 1365.4238 1458.9479
##  [8,] 1574.2285 1679.1744
##  [9,] 1836.5170 1954.9911
## [10,] 1346.8125 1433.8790
## [11,]  874.0467  934.9444
## [12,]  979.0984 1044.9725
## [13,] 1086.5072 1158.2054
## [14,] 1289.4371 1372.1717
## [15,] 1021.8231 1088.1689
## [16,]  872.0694  928.5295
## [17,]  440.8650  471.6625
## [18,]  433.1818  463.2819
## [19,]  491.3771  524.0035
## [20,]  487.7213  520.9690
## [21,]  509.7371  544.6251
## [22,]  576.7701  613.5803
## [23,]  646.6260  688.2954
## [24,]  642.8111  683.8763
## [25,]  547.0800  582.8194
## [26,]  474.7431  505.3495
## [27,]  411.4239  439.0544
## [28,]  460.6455  489.4751
```