Marketing Analytics and Forecasting | Lancaster University Management School

Session 3. iETS: Intermittent demand

Demand Forecasting with the ADAM

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Contents

Introduction

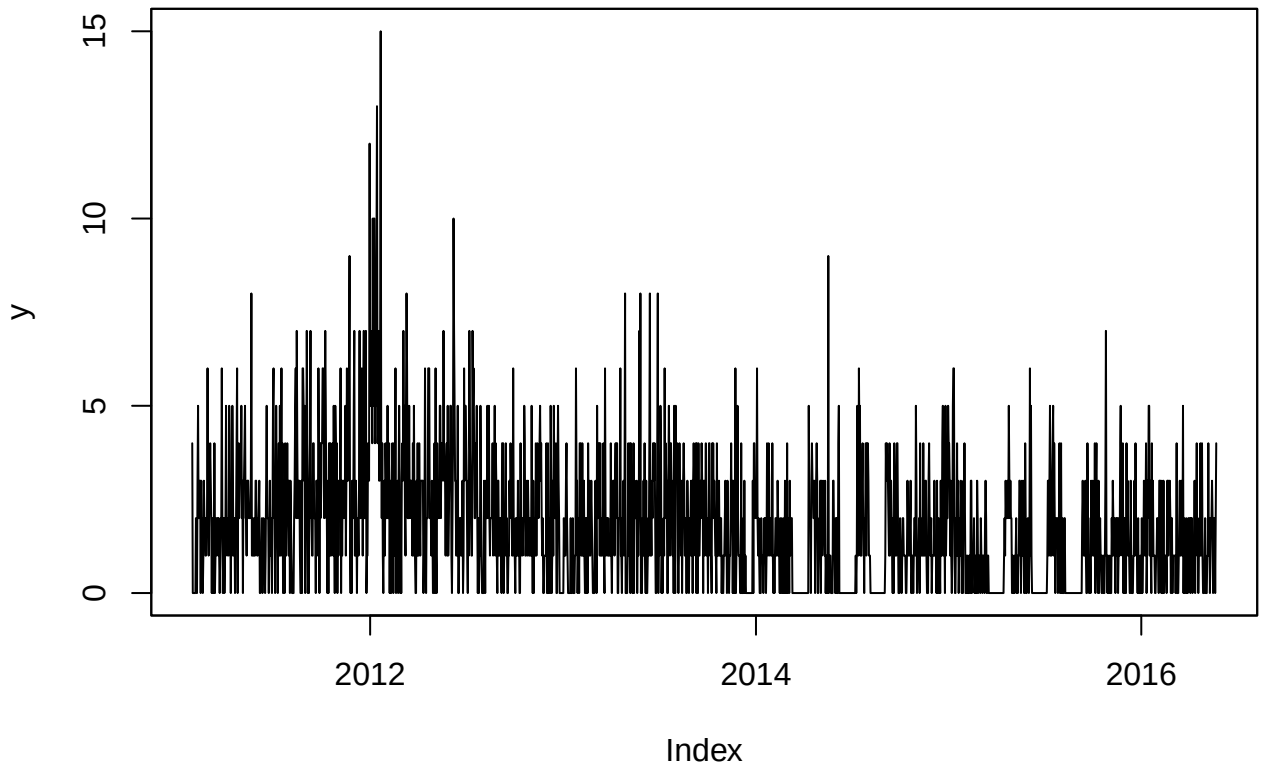
We continue workign with the same packages `greybox` and `smooth`, so do not forget to load them:

```
library(greybox)
library(smooth)
```

iETS

For this task, we will use time series number 2340 from the M5 dataset, which we provide in the file `M5N2340.Rdata`:

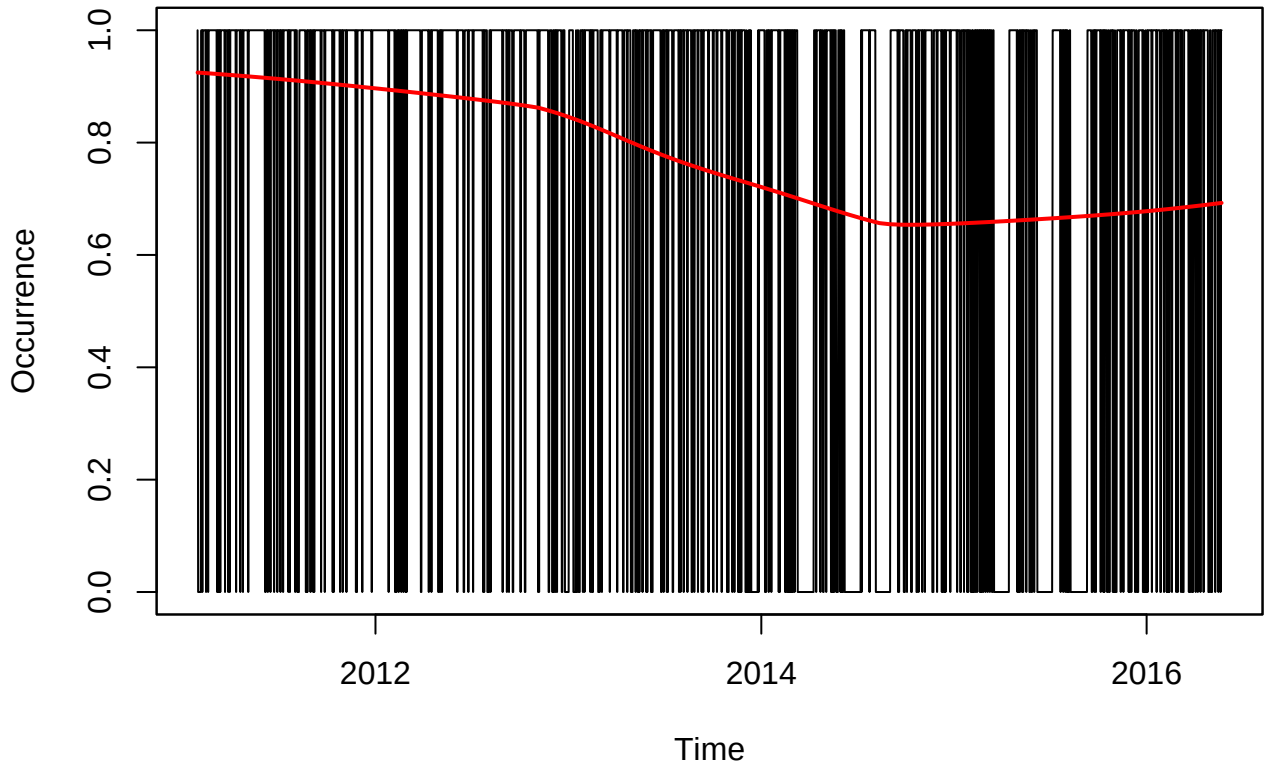
```
load("M5N2340.Rdata")
plot(y)
```



Question What patterns do you see in the data?

For this data, we will try several occurrence models and see which one of them captures the dynamics better. The data shows that the demand slows down, introducing more zeroes at the end, which can be visualised in the following way:

```
# Create occurrence variable
ot <- (y!=0)*1
# Plot it
plot(ot, type="l", ylab="Occurrence", xlab="Time")
# Add LOWESS line
lines(time(ot), lowess(ot)$y, col="red", lwd=2)
```



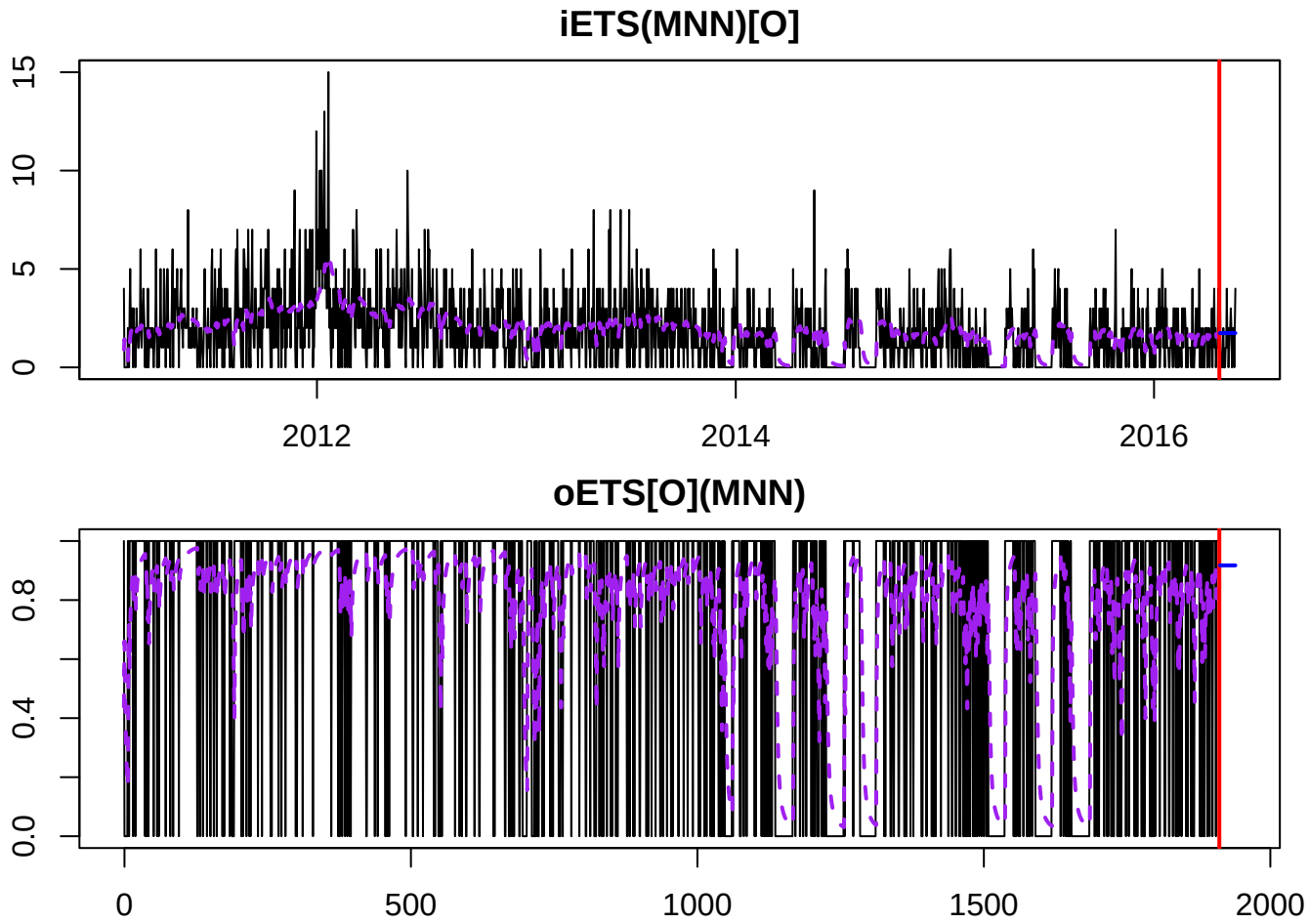
In the plot above, we've added LOWESS line to see clearer how the demand occurrence changes on average over time. The main message here is that the probability of occurrence used to be close to one, but it has started declining closer to the end of the data.

As discussed in the lecture, the "odds ratio" model should be more appropriate in this case:

```
adamMNNM5Odds <- adam(y, "MNN", occurrence="odds", h=28, holdout=TRUE)
```

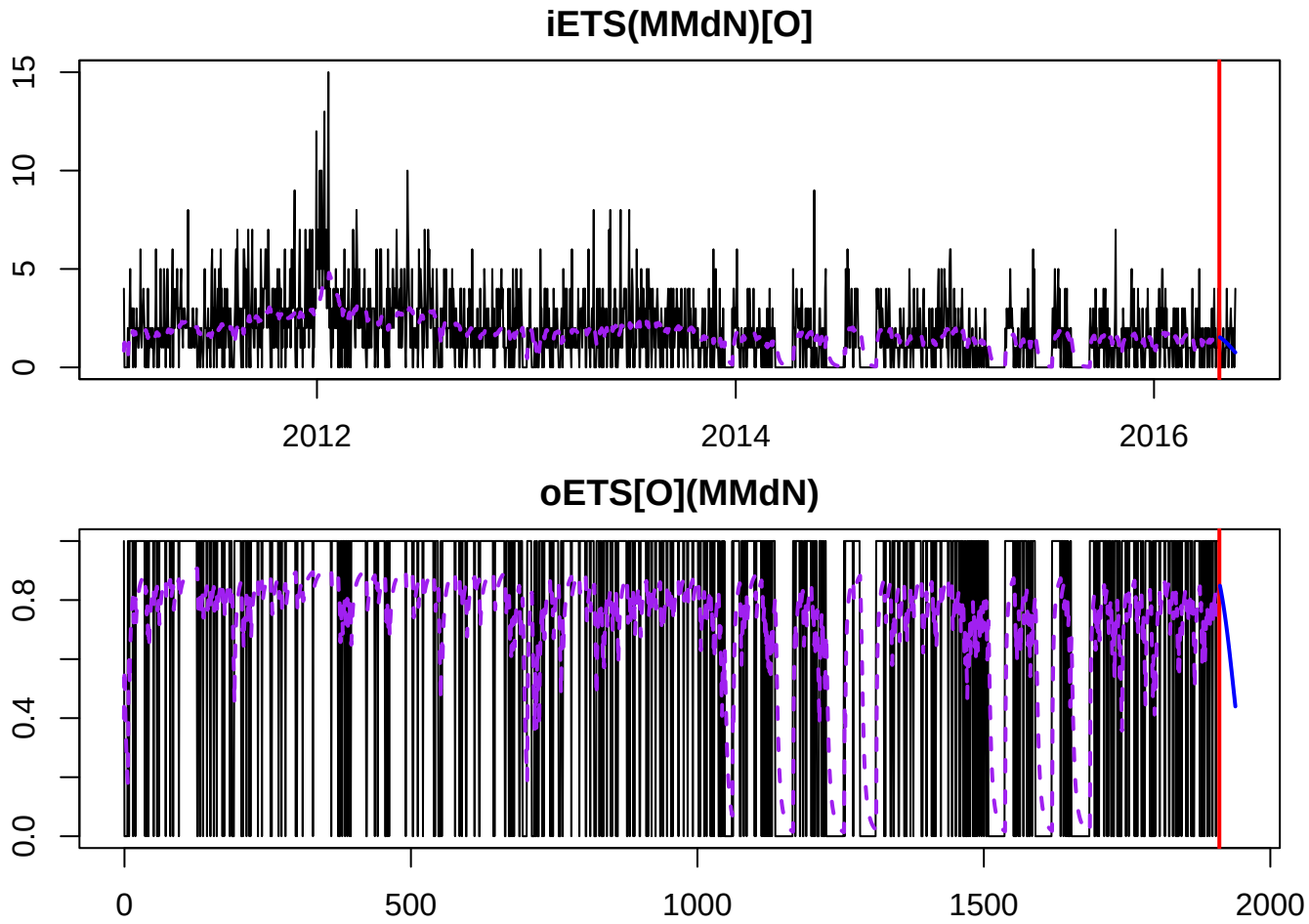
The code above tells ADAM to fit iETS(M,N,N)$_O$(M,N,N) model. We can see how it fits the demand sizes and demand occurrence using the following commands:

```
par(mfcol=c(2,1), mar=c(2,2,2,1))
plot(adamMNNM5Odds, 7)
plot(adamMNNM5Odds$occurrence)
```



If we think that the decline in both demand occurrence and sizes will continue, we can use a different model. Here, for example, how the iETS(M,Md,N)$_O$(M,Md,N) fits the data:

```
adamMMdNM5Odds <- adam(y, "MMdN", occurrence="odds", h=28, holdout=TRUE)
# Plot the thing
par(mfcol=c(2,1), mar=c(2,2,2,1))
plot(adamMMdNM5Odds, 7)
plot(adamMMdNM5Odds$occurrence)
```

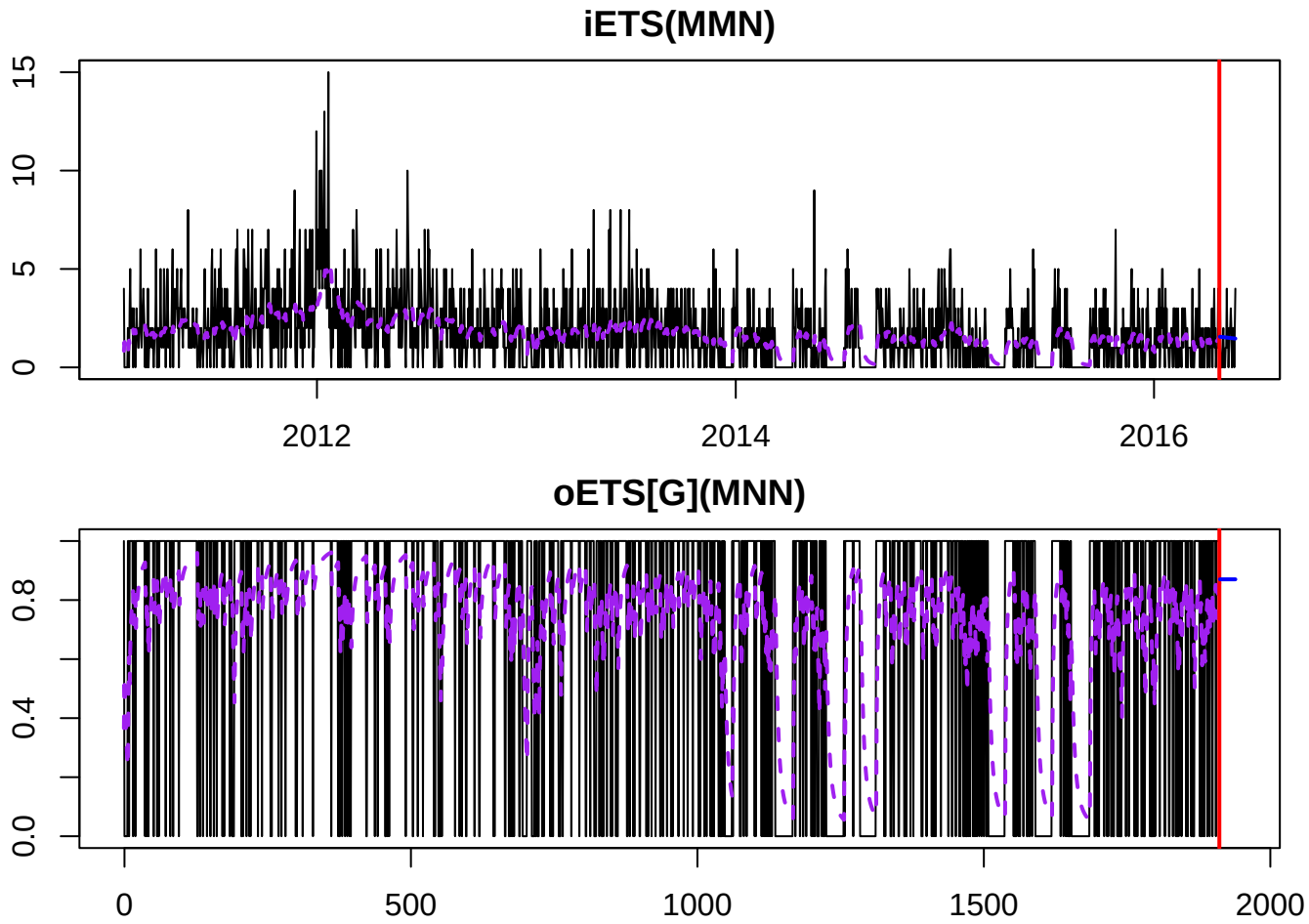


The iETS(M,Md,N)$_O$(M,Md,N) predicts a much more radical decline in occurrence than expected. We could use other occurrence models with a variety of multiplicative ETS models to see which one does better in terms of information criteria. ADAM allows automating this:

```
adamYYNM5Auto <- adam(y, "YYN", occurrence="auto", h=28, holdout=TRUE)
```

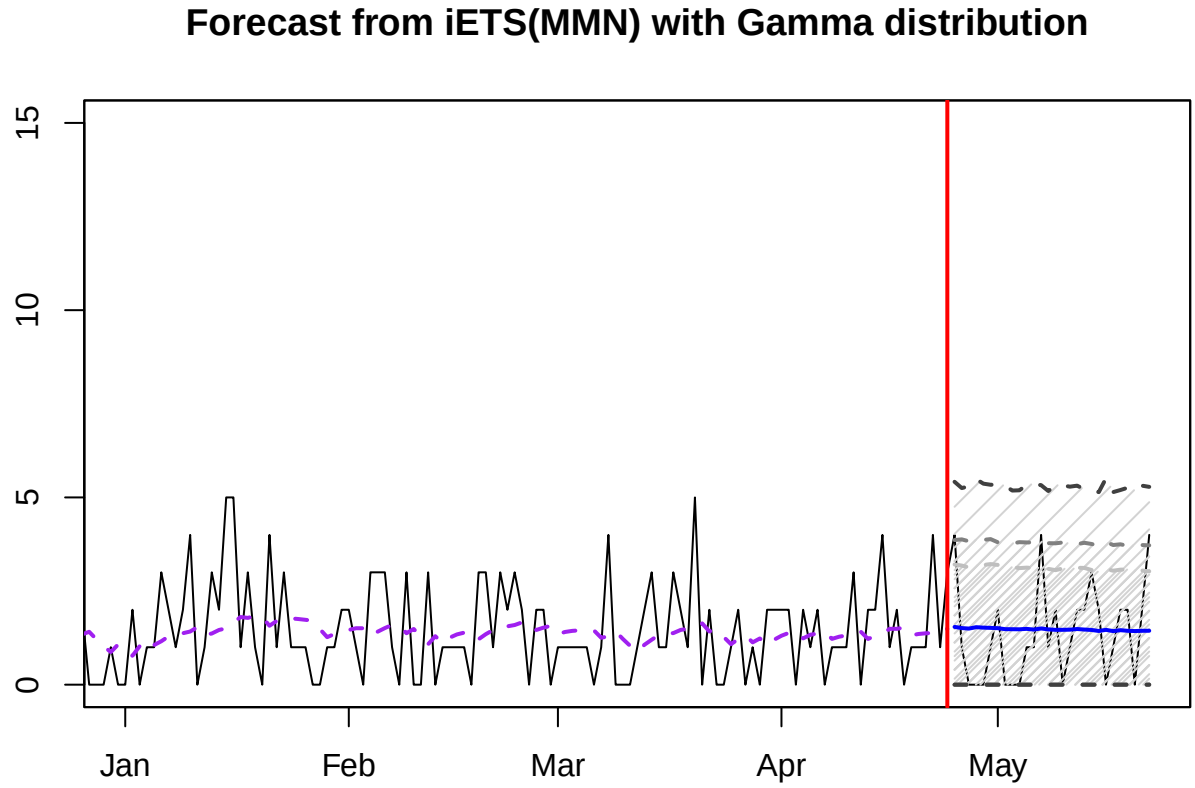
The code above will select the most appropriate (in terms of AICc) ETS model for demand sizes and demand occurrence. In this case, the resulting models might not be the same (in contrast with previous commands). Here is what we get:

```
par(mfcol=c(2,1), mar=c(2,2,2,1))
plot(adamYYNM5Auto, 7)
plot(adamYYNM5Auto$occurrence)
```



After finding the best model, we can produce forecasts from it:

```
# Produce forecast with different confidence levels,
# Use only upper bound and do 10000 iterations (simulated intervals)
forecast(adamYYNM5Auto, h=28, interval="simulated",
         level=c(0.9,0.95,0.99), side="upper", nsim=10000) |>
    # Produce a plot with zoom for the year 2016
    plot(xlim=c(as.Date("2016-01-01"),end(adamYYNM5Auto$holdout)))
```



The other important question is how the forecasts from the model are used in practice. It might make sense to generate values cumulative over the lead time. In that case, we can ask `forecast()` to do that via `cumulative=TRUE`.

Additional materials

For some additional examples on ETS implemented in `smooth` run:

```
vignette("adam","smooth")
```

Some additional resources on exponential smoothing:

1. Post about the iETS paper;
2. Chapter 13 in ADAM;
3. ETS in the blog of Ivan Svetunkov;
4. Posts on the functions in smooth package;
5. Posts of Nikos Kourentzes on exponential smoothing.