The file *WaveletDetectionPrograms.zip* contains four Matlab functions:

- *OutlierFiltering.m*
- *OutlierDetection.m*
- *Threshold.m*
- *detectsubroutine.m*

that implement the outlier detection procedure proposed by Grané and Veiga (2010), published in the paper *Wavelet-based detection of outliers in financial time series,* **Computational Statistics and Data Analysis**, vol. 54, 2580—2593 (2010).

Here we give a brief explanation of those functions. We understand that the reader is a Matlab user.

OutlierFiltering.m

This Matlab function cleans the outliers in a return series that has been previously fitted to a volatility model with completely specified distribution for the errors. It implicitly calls *detectsubroutine.m*.

```
newseries=OutlierFiltering(y,u,k)
```

It has three input arguments *(y,u,k)*, which stand for:

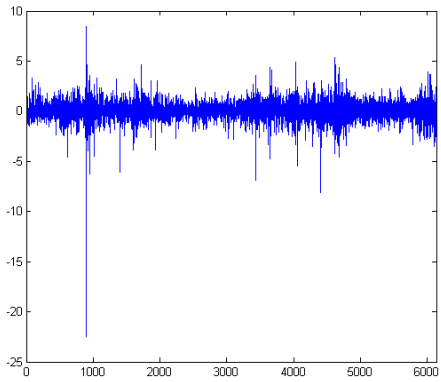
- *y* is the return series that you are interested in filtering,
- *u* is the series of residuals according to the fitted model,
- *k* is the threshold value (see our paper for several values of *k*, depending on the size of the return series).

The function returns only one output, *newseries*, which is the cleaned series.

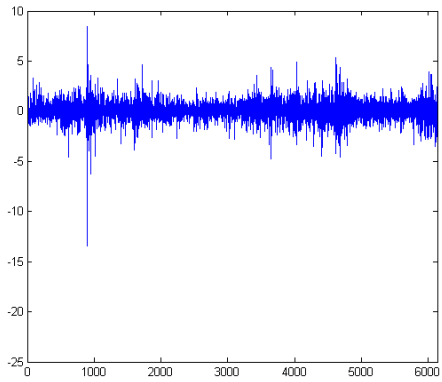
Example: Dow Jones return series fitted as a Gaussian GARCH(1,1) model.

```
y=load('dj_returns.txt');
u=load('res_dj_garch_normal.txt');
k=4.1432;
newseries=OutlierFiltering(y,u,k)
```

We plot both series, before and after cleaning:



dj_returns



newseries

Notice that *OutlierFiltering.m* function does not return the positions where outliers have been detected. If you are interested in those positions, you may use the *OutlierDetection.m* function.

OutlierDetection.m

This Matlab function detects the possible outliers (according to a certain threshold) in a series of residuals.

```
position=OutlierDetection(u,k)
```

It has two input arguments *(u,k)*, which stand for:

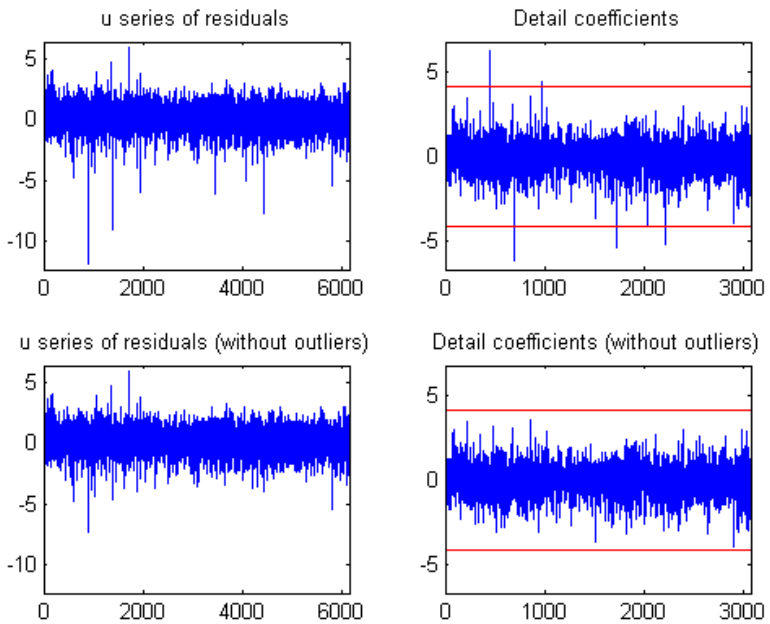
- *u* is the series of residuals according to the fitted model,
- *k* is the threshold value (see our paper for several values of *k*, depending on the size of the return series).

The function returns one numerical output, *position*, which is a vector containing the positions of the outliers in the original return series.
This function also returns a graphical output: Four panels containing the original series of residuals, the first level wavelet detail coefficients with the threshold bands, the outlier filtered series of residuals and the corresponding first level wavelet detail coefficients.

Example: Dow Jones return series fitted as a Gaussian GARCH(1,1) model.

```
u=load('res_dj_garch_normal.txt');
k=4.1432;
position=OutlierDetection(u,k)

position =
     896
    1399
    1928
    3431
    4053
    4407
```



If the size of your return series is very different from those reported in our paper, you can use the *Threshold.m* function to compute your own threshold *k*.

Threshold.m

This function computes the threshold value to be used in the programs *OutlierDetection.m* and *OutlierFiltering.m*.

k=Threshold(alpha,n)

It has two input arguments *(alpha,n),* which stand for

- *alpha* is the significance level (hence, *1-alpha* is the confidence level),
- *n* is the size of the return series.

The function returns only one output, *k*, which is the threshold value.