ArDec Tutorial

Updated 29 April 2013

Introduction

This document contains simple illustrative examples of usage of the R-package ArDec.

The pakage ArDec implements a time series decomposition procedure based on the dynamic linear representation of an autoregressive process which is particularly useful for the extraction of trend and periodic components.

Getting started

Download the package from CRAN (`http://cran.r-project.org`) or in R

```
> install.packages("ArDec")
```

Load the library

```
> library(ArDec)
```

Start the help system

```
> help.start()
```

Data

Load the example data (monthly temperature in Central England from 1723-1970)

```
> data(tempEng)
```

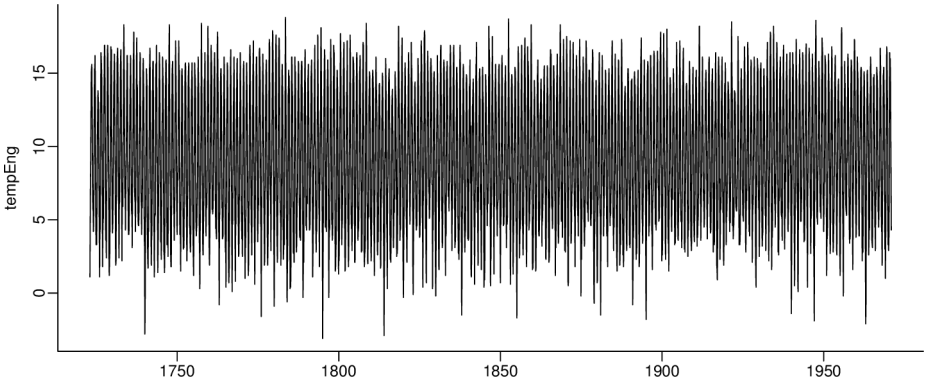
Check the structure of this R object

```
> str(tempEng)
```

```
> Time-Series [1:2976] from 1723 to 1971: 1.1 4.4 7.5 8.9 11.7 15 15.3 15.6
```

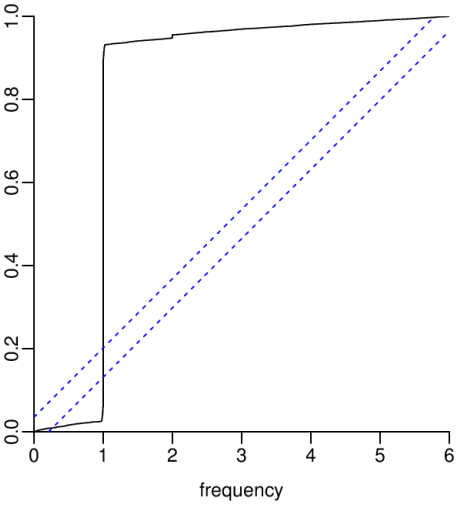
Plot the data

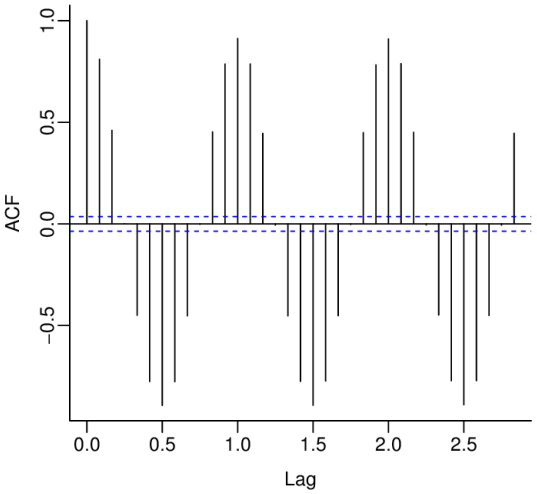
```
> plot(tempEng)
```



Some exploratory time series analysis

```
> cpgram(tempEng)
> acf(tempEng)
```





The time series plot, the cumulative periodogram and the sample autocorrelation function show a strong annual periodicity in the data. The next section illustrates how to decompose this time series using ArDec

ArDec decomposition

1. Fitting an autoregressive process to the data

```
> model=ardec.lm(tempEng)
```

In this case the method used to fit the model is not specified, so the Burg method is used. A big model (order of the autoregressive parameter $p = 34$) is fitted to the time series of temperature in central England

```
> model
Call: lm(formula = y ~ -1 + X, x = TRUE)
Coefficients:
```

X1	X2	X3	X4	X5	X6
0.2942447	0.0480123	-0.0166935	-0.0050246	-0.0119893	0.0090816
X7	X8	X9	X10	X11	X12
-0.0233188	-0.0382977	0.0053468	0.0562919	0.0622145	0.1043717
X13	X14	X15	X16	X17	X18
0.0549423	-0.0598093	-0.0373727	-0.0317938	-0.0089850	-0.0259883
X19	X20	X21	X22	X23	X24
-0.0002747	-0.0513517	0.0027275	0.0270081	0.0493173	0.1266952
X25	X26	X27	X28	X29	X30
0.1025295	0.0093870	-0.0639103	-0.0136526	-0.0274514	-0.0336428
X31	X32	X33	X34		
-0.0130935	-0.0382225	-0.0088768	0.0443993		

2. ArDec core decomposition, based on the parameters estimated above

```
> coef=model$coefficients
> decomposition=ardec(tempEng,coef)
```

The previous command gives an object (decomposition) of class ardec

```
> str(decomposition)
List of 3
$ period   : num [1:34] 12 -12 5.99 -5.99 8.42 ...
$ modulus  : num [1:34] 1 1 0.964 0.964 0.946 ...
$ comps    : cplx [1:34, 1:2976]  NA  NA  NA ...
```

This object is a list, containing information on the estimated components (period, modulus or damping factor and all the 34 components themselves).

The output includes both signs of the imaginary eigenvalues obtained from the canonical matrix (see the references for the mathematical details), so the period shows the two (positive and negative) values, for the same modulus (real part of the eigenvalue). Please note that although ArDec extracts as many components as the estimated order for the autoregressive process (in this case 34), not all are of interest or meaningful - only the components least damped (with modulus closer to 1) are relevant.

3. Extraction of periodic components

The function ardec.periodic retrieves the components for a given specified period

```
> output=ardec.periodic(tempEng,12)
```

The result is a list with the retrieved ArDec component

```
> str(output)

List of 3
$ period   : num 12
$ modulus  : num 1
$ component: num [1:2976] NA NA NA NA NA NA NA NA NA NA ...
```

The component can be set as an independent R object

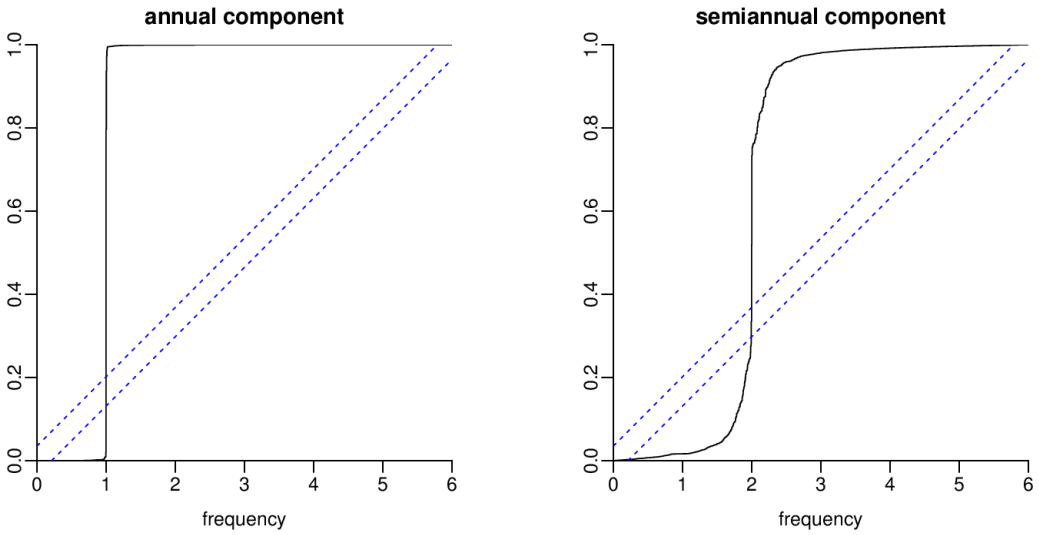
```
> annual=ts(output$component,start=1723,frequency=12)
```

or for the semi-annual component

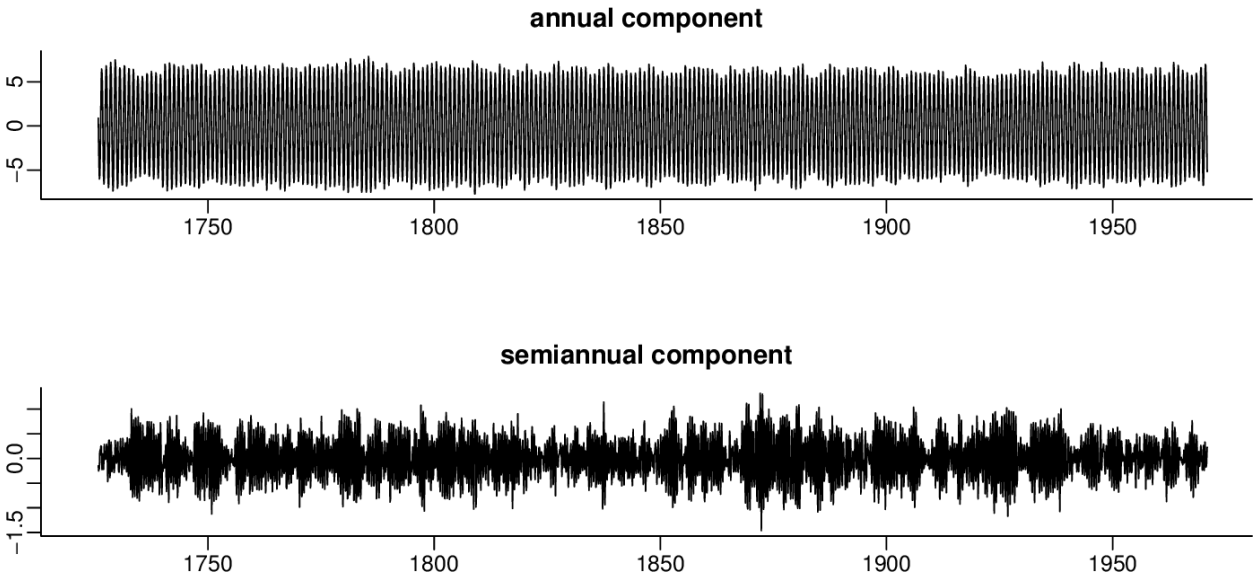
```
> semiannual=ts(ardec.periodic(tempEng,6)$component,start=1723,frequency=12)
```

The obtained components can be further analysed

```
> cpgram(annual)
> cpgram (semiannual)
```



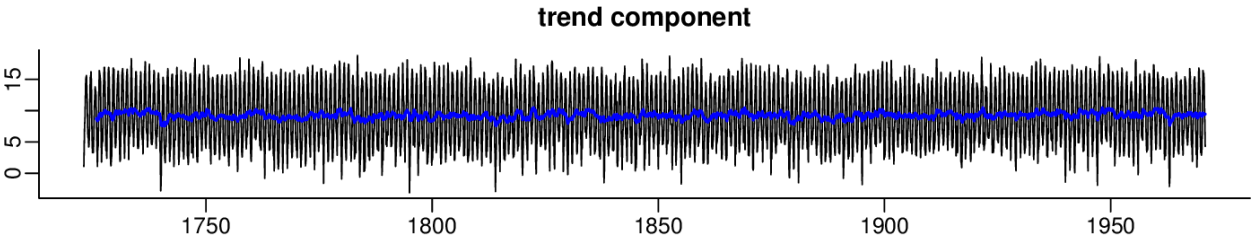

```
> plot(annual,xlab="",ylab="",main="annual component")
> plot(semiannual,xlab="",ylab="",main="semiannual component")
```

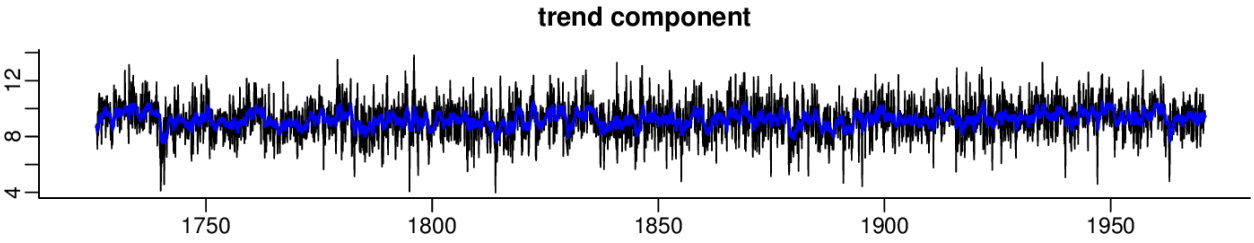


4. Extraction of trend component

```
> trend=ts(ardec.trend(tempEng)$trend,start=1723,frequency=12)
> plot(tempEng,xlab="",ylab="",main="trend component")
> lines(trend+mean(tempEng),col=4,lwd=2)

> plot(tempEng-annual,xlab="",ylab="",main="trend component")
> lines(trend+mean(tempEng),col=4,lwd=2)
```





References

When using this software please cite

- Barbosa, SM, Silva, ME, Fernandes, MJ (2008), Changing seasonality in North Atlantic coastal sea level from the analysis of long tide gauge records. Tellus, 60A, 165-177.
- West, M. (1997), Time series decomposition. Biometrika, 84, 489-494.