1 Installation

Installing hydroGOF:

> install.packages("hydroGOF")

2 Setting Up the Environment

1. Loading the hydroGOF library, which contains data and functions used in this analysis.
   
   > library(hydroGOF)

2. Loading observed streamflows of the Ega River (Spain), with daily data from 1961-Jan-01 up to 1970-Dec-31

   > require(zoo)
   > data(EgaEnEstellaQts)
   > obs <- EgaEnEstellaQts

3. Generating a simulated daily time series, initially equal to the observed values (simulated values are usually read from the output files of the hydrological model)

   > sim <- obs

4. Computing the numeric goodness-of-fit measures for the "best" (unattainable) case

   > gof(sim=sim, obs=obs)

   [,1]
   ME 0
   MAE 0
   MSE 0
   RMSE 0
   NRMSE % 0
   PBIAS % 0
5. Randomly changing the first 2000 elements of 'sim', by using a normal distribution with mean 10 and standard deviation equal to 1 (default of 'rnorm').


6. Plotting the graphical comparison of 'obs' against 'sim', along with the numeric goodness-of-fit measures for the daily and monthly time series

> ggof(sim=sim, obs=obs, ftype="dm", FUN=mean)

3 Removing Warm-up Period

1. Using the first two years (1961-1962) as warm-up period, and removing the corresponding observed and simulated values from the computation of the goodness-of-fit measures:
> ggof(sim=sim, obs=obs, ftype="dm", FUN=mean, cal.ini="1963-01-01")

2. Verification of the goodness-of-fit measures for the daily values after removing the warm-up period:

```r
> sim <- window(sim, start=as.Date("1963-01-01"))
> obs <- window(obs, start=as.Date("1963-01-01"))
> gof(sim, obs)

[,1]
ME  4.34
MAE 4.34
MSE 43.87
RMSE 6.62
NRMSE % 36.40
PBIAS % 29.20
RSR 0.36
rSD 1.04
NSE 0.87
mNSE 0.63
rNSE -0.52
d  0.97
md  0.81
rd  0.64
cp  0.44
r  0.96
R2  0.93
bR2 0.83
KGE  0.70
VE  0.71
```
4 Analysis of the Residuals

1. Computing the daily residuals (even if this is a dummy example, it is enough for illustrating the capability)

   > r <- sim-obs

2. Summarizing and plotting the residuals (it requires the hydroTSM package):

   > library(hydroTSM)
   > smry(r)

<table>
<thead>
<tr>
<th>Index</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>1963-01-01 0.0000</td>
</tr>
<tr>
<td>1st Qu.</td>
<td>1964-12-31 0.0000</td>
</tr>
<tr>
<td>Median</td>
<td>1966-12-31 0.0000</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
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<td>&lt;NA&gt; -1.8306</td>
</tr>
<tr>
<td>NA's</td>
<td>&lt;NA&gt; 2.0000</td>
</tr>
<tr>
<td>n</td>
<td>&lt;NA&gt; 2922.0000</td>
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   > # daily, monthly and annual plots, boxplots and histograms
   > hydroplot(r, FUN=mean)

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   > hydroplot(r, FUN=mean)
3. Seasonal plots and boxplots

```r
> # daily, monthly and annual plots, boxplots and histograms
> hydroplot(r, FUN=mean, pfreq="seasonal")
```

This tutorial was built under:

[1] "x86_64-pc-linux-gnu (64-bit)"

[1] "R version 3.4.1 (2017-06-30)"

[1] "hydroGOF 0.3-10"