

# Time Series A2

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The data set `LakeHuron` contains annual measurements of the height in feet (one foot equals 12 inches) of Lake Huron in the North American Great Lakes region from 1875 to 1972. The data can be accessed in R by typing `data(LakeHuron)`.

1. Obtain a time series plot of the data.

**Solution** This is observed in plot (a) **As required.**

2. Obtain the correlogram of the data and comment (with justification) on whether a white noise process would be a suitable model for the data.

**Solution** This plot is plot (b) - white noise would be a suitable model for the data if we saw little or no correlation between any two points (i.e. if the correlation fit between the two blue lines). In this case we see that up until 10 steps, this does not hold. So we cannot treat this as a white noise process. **As required.**

3. Smooth the data using a three-point moving average filter and obtain a plot showing the raw and smoothed data.

**Solution** This is shown in plot (c), where the black line is the raw data, and blue line is the smoothed data. **As required.**

4. Smooth the data twice using a three-point moving average filter and obtain a plot showing the raw and smoothed data.

**Solution** This is shown in plot (d), where the black line is the raw data, and the purple line is the twice smoothed data. **As required.**

5. Smooth the data using a five-point moving average filter and obtain a plot showing the raw and smoothed data.

**Solution** This is shown in plot (e), where the black line is the raw data, and the red line is the smoothed data. **As required.**

6. Smooth the data using a smoothing spline and obtain a plot showing the raw and smoothed data.

**Solution** This is shown in plot (f), where the black line is the raw data, and the green line is the spline-smoothed data. **As required.**

7. Compare the effects of the different methods of smoothing on this series.

**Solution** From plots (c) through to (f) the effects of the different methods can be seen. The 3-point smoother has little effect on the data, smoothing only the very sharp portions. Repeating this continues to smooth over these portions giving more of a curve, maintaining most of the features of the graph. The 5-point smoother does a better job of keeping the features of the graph, but lessens the effect of them (note the last trough is roughly halved in amplitude in this case). Lastly, the smoothing spline changes the data very little, only removing the very rapid changes, and keeping a more curved structure. **As required.**

8. Calculate and plot the differenced series.

**Solution** This is done in the code and shown in plot (g) **As required.**

9. Obtain the correlogram of the differenced data and also a normal quantile plot. Comment (with justification) on whether Gaussian white noise is a reasonable model for the differenced series.

**Solution** These plots are (h) and (i) respectively. The assumption of Gaussian white noise involves assuming that the data is independent and identically distributed  $N(0, \sigma^2)$ . Plot (h) shows that the correlation between them is within an acceptable range (although the lag 9 is questionable), and plot (i) shows the data are roughly normally distributed, implying that this assumption is reasonable for the differenced data. **As required.**

## 1 Plots and Code

### 1.1 Code

```
setwd("~/Uni/2018/Sem2/Time Series")
pdf(file="A2Plots.pdf")
data(LakeHuron)
#It is already time series format
plot(LakeHuron)
#Correlogram
acf(LakeHuron)
#looks like there is some dependence between the values up until lag 10

##Different smoothers
#3 point
plot(LakeHuron)
lines(filter(LakeHuron,filter=rep(1/3,3)),col="blue")
#twice 3 point
plot(LakeHuron)
lines(filter(filter(LakeHuron,filter=rep(1/3,3)),filter=rep(1/3,3)),col="purple")

#5 point
plot(LakeHuron)
lines(filter(LakeHuron,filter=rep(1/5,5)),col="red")

#Smoothing spline
plot(LakeHuron)
lines(smooth.spline(LakeHuron),col="#00aa00")

##Differenced series
dLakeHuron = diff(LakeHuron)
plot(dLakeHuron)
acf(dLakeHuron)
qqnorm(dLakeHuron)

dev.off()
```

## 1.2 Plots

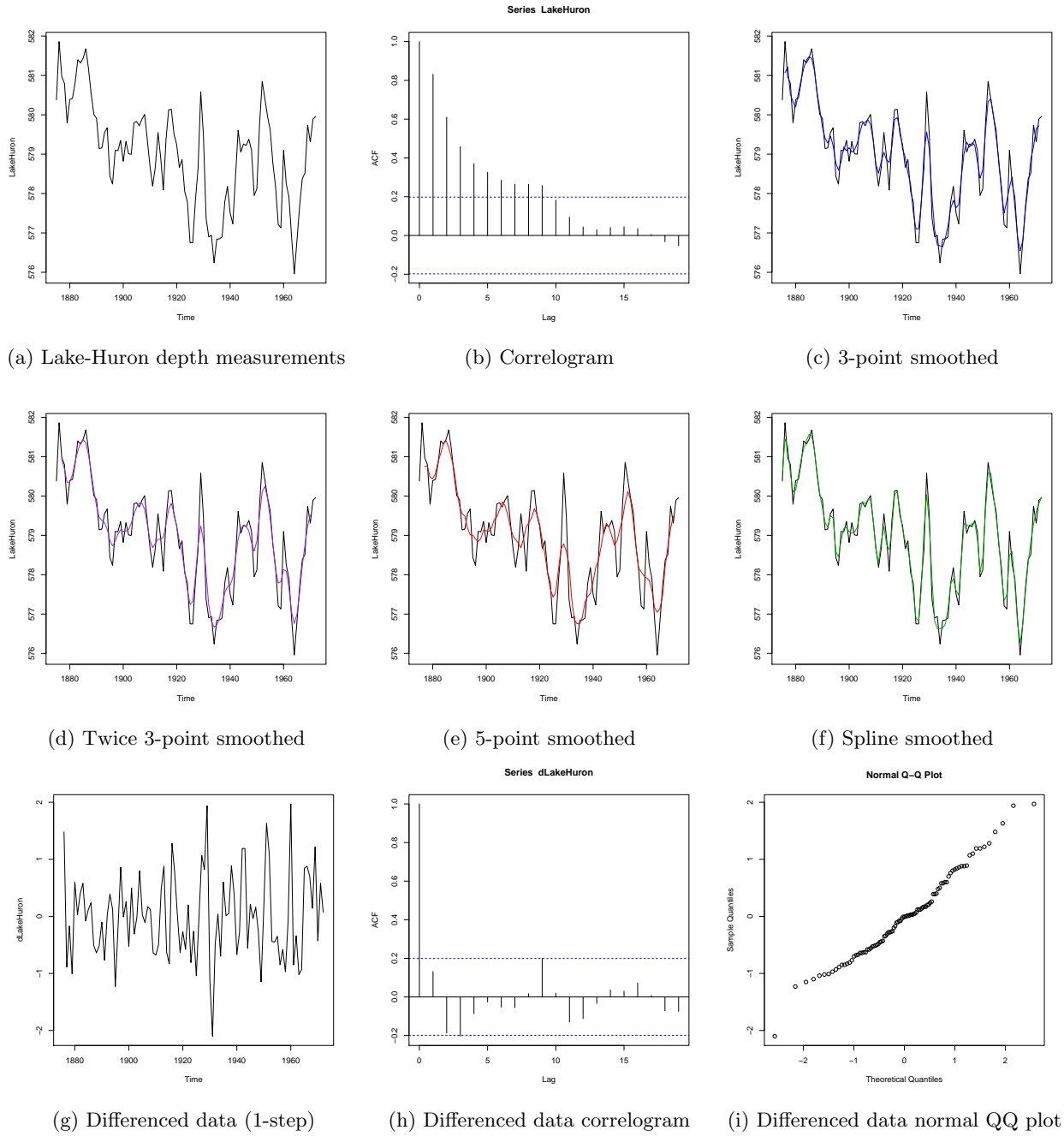


Figure 1: Checks on the Lake Huron data