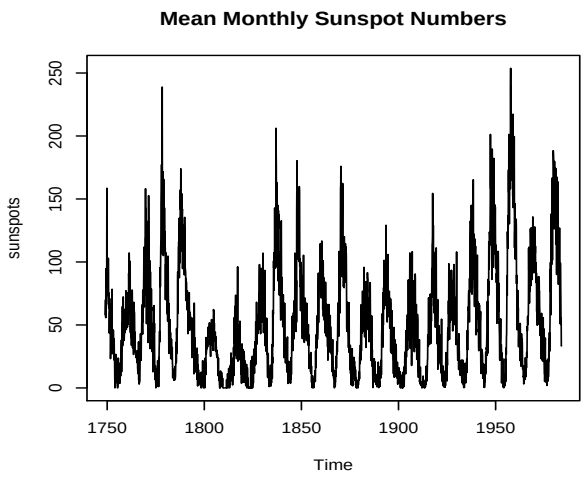
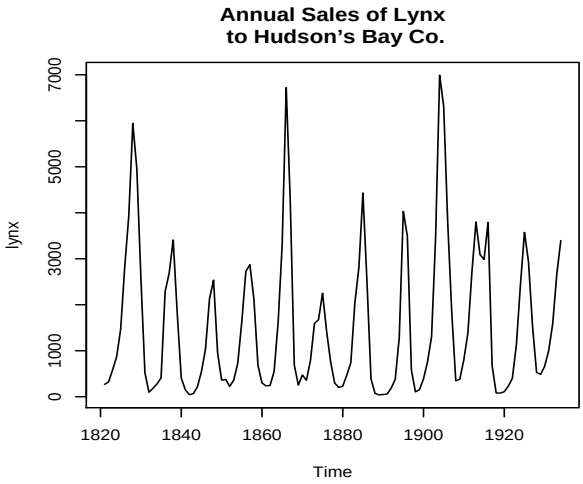
STAT 804: Time Series

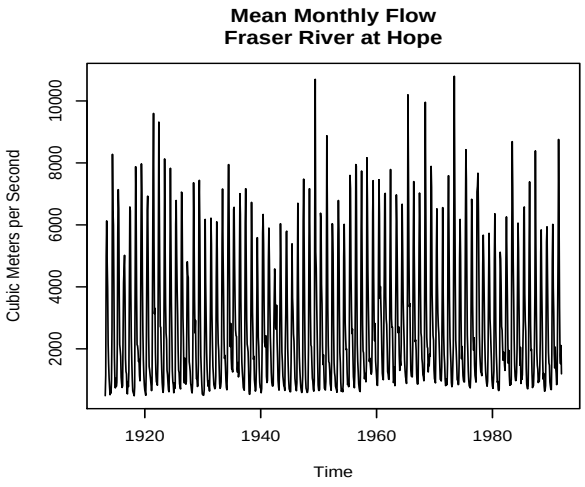
Introduction

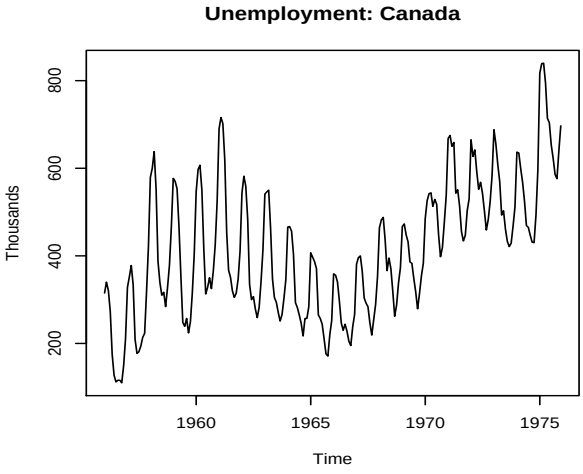
- Plots of some time series
- Discuss series using some of the jargon we will study.
- Basic classes of models.
- Existence of consistent estimates.

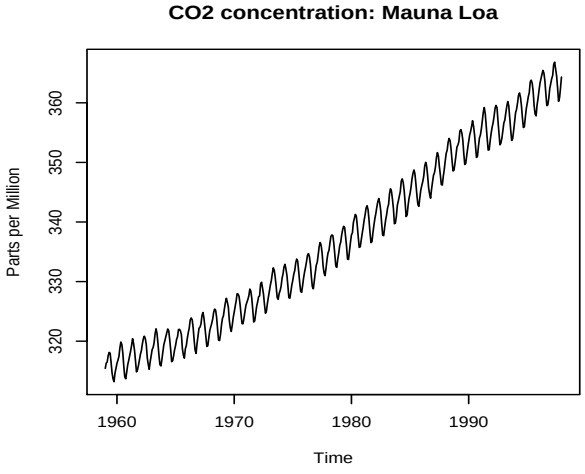
Plots of some series

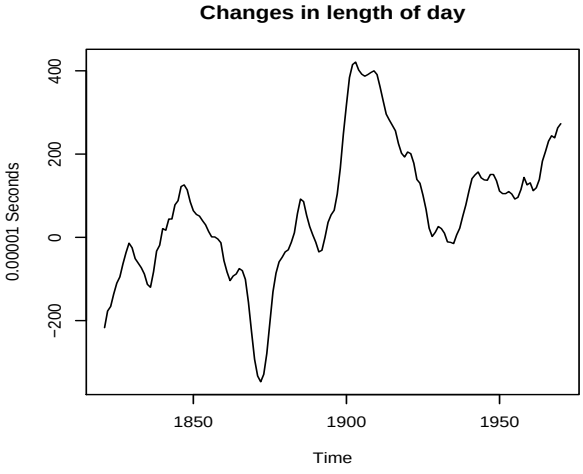












Comments on the data sets:

- Top left: Sunspot data. Each month average number of sunspots is recorded. Note:
  - apparent periodicity
  - large variability when series at high level; small variability when at low level.

  This series is likely to be quite stationary over the time span we have been able to observe it, though it may have a nearly perfectly periodic component.

- Top right: Annual sales of lynx pelts to the Hudson's Bay Company. Note:
  - Clear cycle of about 10 years in length.
  - longer term cycle?
  - Is the cycle produced by a strictly periodic phenomenon or by a dynamic system close to a periodic system?

- Middle left: Mean monthly flow rates for the Fraser River at Hope. Note:
  - Signs of lower variability at low levels suggesting transformation.
  - Clear annual cycle which will have to be removed to look for stationary residuals.

- Middle right: Canadian monthly unemployment number. Note:
  - probable presence of slow upward trend; such a trend should be present in the presence of a growing population.
  - not stationary.
  - trend not too linear with some apparent long term cycles perhaps which produce an S shaped curve.

- Lower left: Carbon Dioxide above Mauna Loa (a Hawaian volcano). Note:
  - Clear trend and an annual cycle
  - but you might well hope that after compensating for these the remainder would be stationary.

- Lower right: Changes in the length of the Earth's day. Note:
  - very smooth graph with long runs going up and down
  - suggests integration.

  We will look at differencing as a method of producing a series with less long range dependence.

Plots made with R using following code:

```
# sunspots data set built into R and SPlus
# lynx data set built into R and SPlus
# flow monthly flows of the Fraser River
#    at Hope, BC.
# unemployment is number unemployed in Canada
#   from Table 64.1: Data by Andrews and Herzberg.
# changes: annual change in length of earth day
#   measured in 0.00001 seconds from Table 20.1
#   in Data by Andrews and Herzberg.
x <- read.table("table64.1",header=F)
unemployment <- ts(c(t(x[,-(1:4)])),
                start=1956, frequency=12)
x <- read.table("table20.1",header=F)
changes <- ts(c(as.matrix(x)[,c(5,7,9,11)])[1:150]
                 ,start=1821, frequency=1)
flow <- scan("FraserRiver.dat",skip=1)
flow <- ts(flow,start=c(1913,3),frequency=12)
postscript("tsplots.ps",horizontal=F)
par(mfrow=c(3,2))
tsplot(sunspots,main="Mean Monthly Sunspot Numbers")
tsplot(lynx,
   main="Annual Sales of Lynx\n to Hudson's Bay Co.")
tsplot(flow, ylab="Cubic Meters per Second",
   main="Mean Monthly Flow\nFraser River at Hope")
tsplot(unemployment,
   main="Unemployment: Canada",ylab="Thousands")
tsplot(co2, main="CO2 concentration: Mauna Loa",
   ylab="Parts per Million")
tsplot(changes,
   main="Changes in length of day", ylab="0.00001 Seconds")
dev.off()
```