Time Series Analysis

Lecture 2

Regression With Time Series, an Intro to Exploratory Time Series Data Analysis, and Time Series Smoothing

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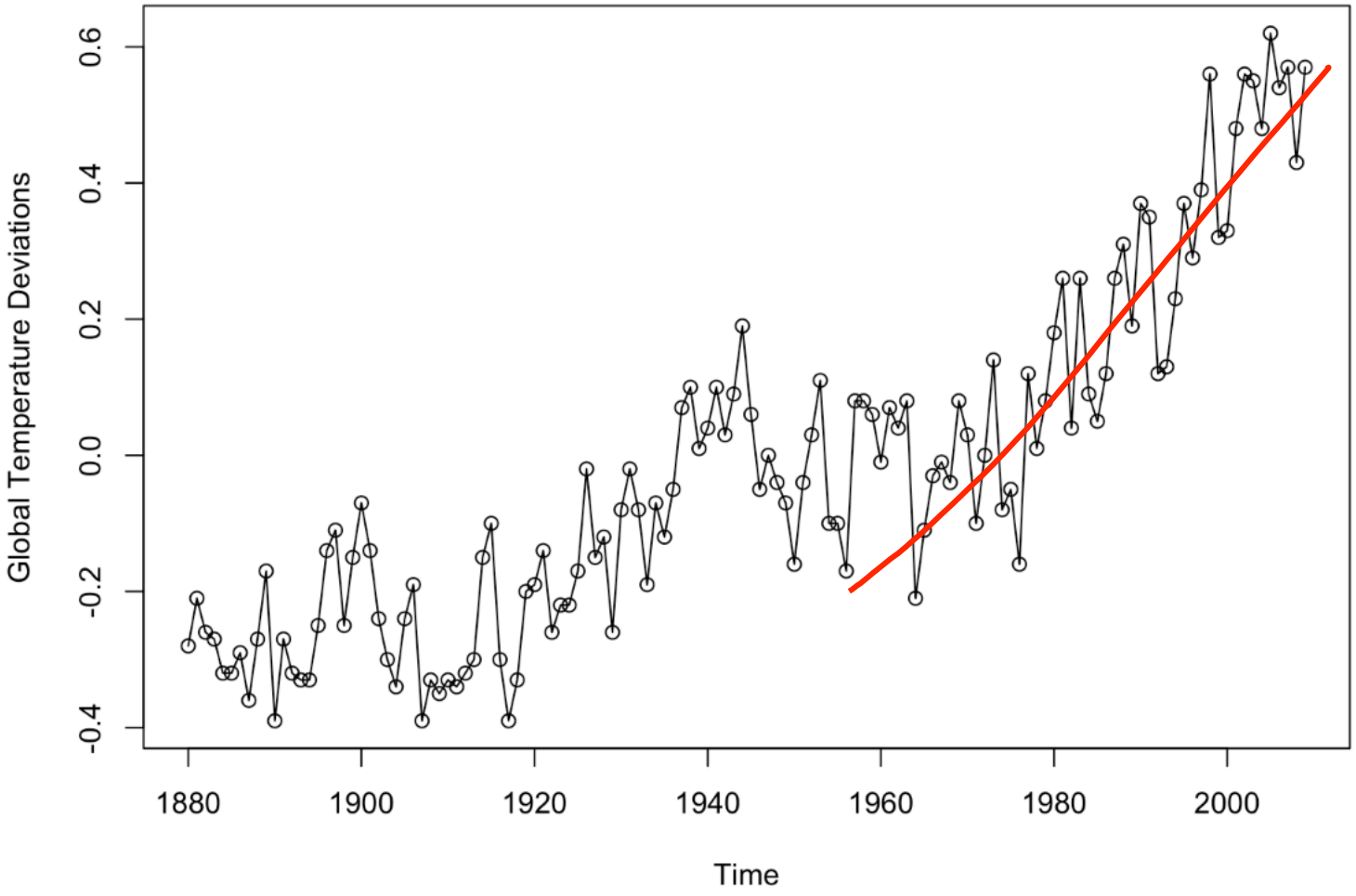
Time Trend Elimination

Global Temperature Deviations

```
plot(gtemp, type="o", ylab="Global Temperature Deviations")
```



Global Temperature in the Last 130 Years

- estimate a linear trend for a series
- detrend the series
- substract the detrend series from the observed series
- model the residuals using a stationary model

```
library(astsa)
# Look at the structure of the data
str(gtemp)
```

```
##  Time-Series [1:130] from 1880 to 2009: -0.28 -0.21 -0.26 -0.27 -0.32 -0.32 -0.29 -0.36 -0.27 -0.17 ...
```

Keeping Track of the Time Index of a Series Is Important in Time Series Analysis

```
#obtain the time index associated with the time series
time(gtemp)
```

```
## Time Series:
## Start = 1880
## End = 2009
## Frequency = 1
##   [1] 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890 1891 1892 1893
##  [15] 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903 1904 1905 1906 1907
##  [29] 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921
##  [43] 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935
##  [57] 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949
##  [71] 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963
##  [85] 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977
##  [99] 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
## [113] 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
## [127] 2006 2007 2008 2009
```

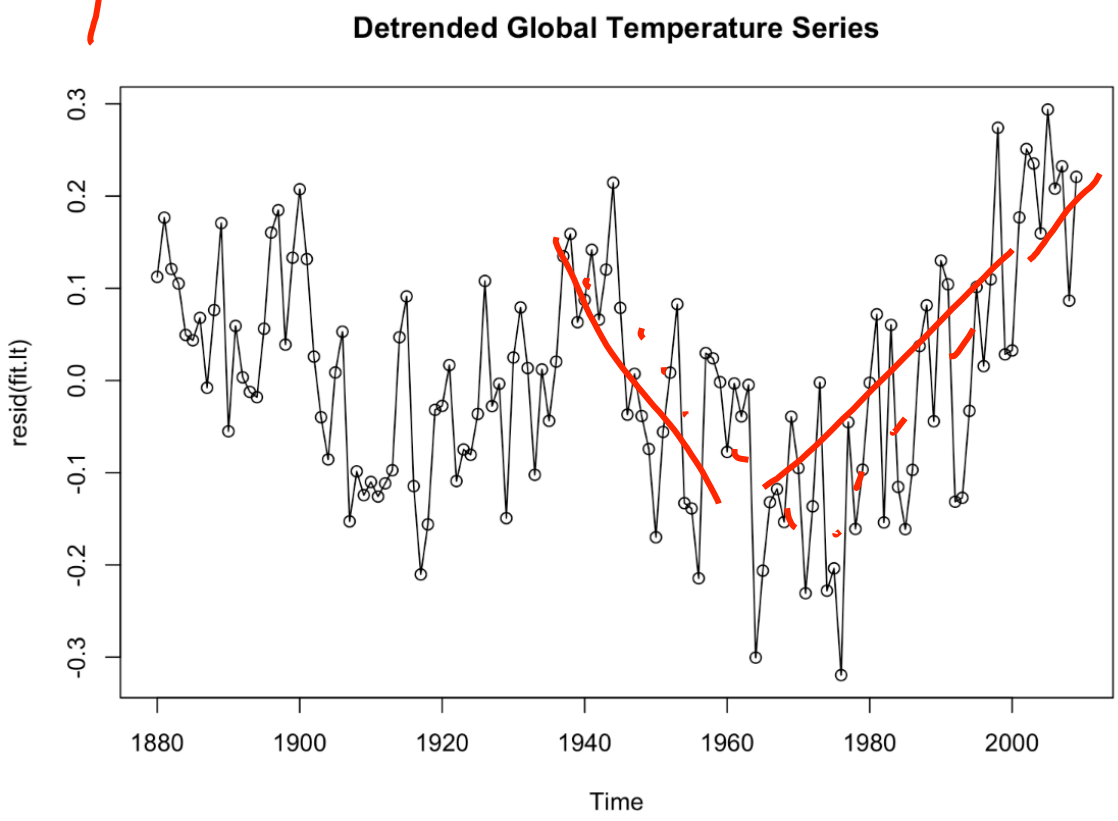
Step 1: Estimate a Linear Trend

```
#Estimate a linear time trend
fit.lt = lm(gtemp ~ time(gtemp), na.action = NULL)
summary(fit.lt)
```

```
##
## Call:
## lm(formula = gtemp ~ time(gtemp), na.action = NULL)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.31946 -0.09722  0.00084  0.08245  0.29383
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.120e+01  5.689e-01  -19.69   <2e-16 ***
## time(gtemp)  5.749e-03  2.925e-04   19.65   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1251 on 128 degrees of freedom
## Multiple R-squared:  0.7511, Adjusted R-squared:  0.7492
## F-statistic: 386.3 on 1 and 128 DF,  p-value: < 2.2e-16
```

Step 2: Detrend the Series

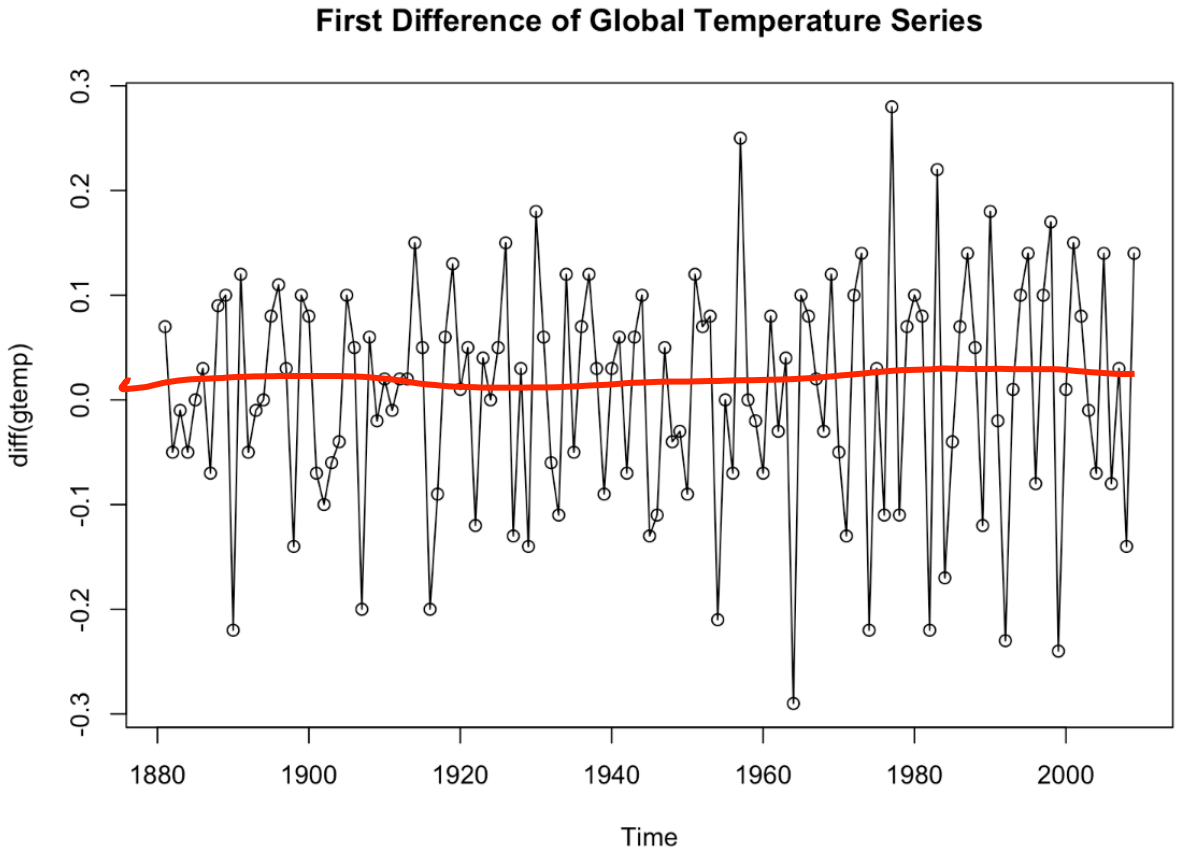
```
plot(resid(fit.lt), type="o", main="Detrended Global Temperature Series")
```



Step 3:
Model the detrended series using a stationary model, if the interest is on modeling the stationary series and when the assumption of stationarity is established.

Another Approach… First Differencing

```
plot(diff(gtemp), type="o", main="First Difference of Global Temperature Series")
```



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