Time series:

Key Ideas:

Periodicity

Short Markov Property

Important separation among:

Trend, periodic, and error components

Trend component:

There is an underlying growth with time or other predictors such as temperature or catalyst.

Periodic component:

This part of the model repeats every period.

Error component:

A fudge factor for things that are not modeled by trend or periodic components.

What do we want to do?

Smooth?

Then we can use a moving average, exponential smoother, or LOWESS. We assume equally spaced observations in time.

Moving average:

1. Arrange the data in time order.

2. Average the 2k+1 points closest points and connect the dots between.

Endpoints????

Exponential smooth:

$$Obs_t = (1-\beta)Obs_{t-1} + (1-\beta)\beta Obs_{t-2} + (1-\beta)\beta^2 Obs_{t-2} + ...$$

LOWESS:

Use the p-percent closest observations to the point of interest x and fit a straight line. Use the predictor at x as the LOWESS fit at x. Do this for all x, or on a tight mesh of x's, and we have our LOWESS. Typical default choices of p range from .5 to .9.

Periodic components:

We usually detrend the data first either by dividing by the estimated trend or subtracting the estimated trend. From the remaining part we wish to estimate the periodic component.

1. Fitting Fourier models such as

$f(t)=x_1+x_2\sin(t)+x_3\cos(t)+x_4\sin(2t)+x_5\cos(2t)+\ldots$.

2. Adding (or multiplying) a periodic component such as a mean shift for each period. For example add 3 parameters. One for morning measurements, one for afternoon measurements, and one for night.

Error component:

After subtracting the trend and periodic component it is what is left. Well are we done?

Autocorrelation

Partial Autocorrelation

Autoregressive Models:

$$X(t) = \mu + \rho_1 X(t-1) + \rho_2 X(t-2) + \ldots + \varepsilon(t).$$

Moving Average

$$X(t) = \mu + \mu(t) + \theta_1 \mu(t-1) + \ldots$$

Mixed Models: