EC313-Fall 2011
Problem Set 1

(Updated 25 September 2011)

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When you write up your answers, your goals should be to (1) be correct, and (2) convince your reader that your answer is correct. It is always helpful if your work is legible and if all steps are presented, possibly with a line of explanation.

In the case of empirical exercises, your goal should be to provide enough information to allow a reader to replicate your answer. This requires a description of data and data sources as well as sa description of your analysis of the data.

Answers which do not achieve these goals will not be awarded full credit.

Problems

1. 'Measuring temperature: the 170 year Thermometer-based record' suggests that we ought to be sceptical of measured temperature data showing an increase in temperature because individual instruments are subject to measurement error. While there are problems with the measured temperature record, this turns out not to be one of the important ones. This exercise asks you to work out the math to demonstrate this.

   Suppose we have two thermometers which each produce a reading T_i for $i = 1,2$. For each reading, this error consists of the true temperature at location i and an error e_i. e_i is random and takes the values x and $-x$ with equal probability. Let T denote the average recorded temperature across the two locations, that is, $T = (T_1 + T_2)/2$. Let $E(T_i)$ denote the expected value of T_i, $var(T_i)$ denote variance, $sd(T_i) = \sqrt{var(T_i)}$ the standard deviation, and $cov(T_i, T_j)$ the covariance. Assume the the errors are independent of each other so that $cov(e_1, e_2) = 0$.

   (a) Calculate $E(T_i)$.

   (b) Calculate $SD(T_i)$.

   (c) Calculate the expected or average value of T.

   (d) Calculate the average error (or standard deviation) for T.

2. in the last problem you'll notice that measurement error of the average is smaller than for the individual instruments. To see how much smaller it is in 'reality', suppose that we have 1000 thermometers (which is about right) and let $T = \frac{1}{1000}\Sigma_{i=1}^{1000} T_i$, where $i = 1,...,1000$. Assume that the covariance between all of the error terms is zero. Find $E(T)$ and $se(T)$ as a function of x.

3. Download measured temperature series for three weather stations (your choice) from

   `http://data.giss.nasa.gov/gistemp/station_data/`

   Plot these data along with a 10 year moving average (in the same figure). Do these plots suggest a warming trend? Be sure to report the data source and the formula you use to calculate the 10 year moving average.

4. Download data CO_2 data for the Vostok Icecore from (use Petit et al 1999 data).

   http://www.ncdc.noaa.gov/paleo/icecore/antarctica/vostok/vostok_co2.html

   Also download the Mauna Loa annual mean CO_2 data from

   http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo_growth

   (cut and paste from the scroll down window).

   (a) Plot a 5 year and 50 year moving average of the Vostok data.
   (b) Plot the Mauna Loa data along with a 5 year moving average.
   (c) What do these two graphs suggest about the relationship between modern and historical concentrations of atmospheric CO_2?

5. Download the oxygen isotope data for the Crete Icecore from

   http://www.ncdc.noaa.gov/paleo/icecore/greenland/gisp/crete/crete_data.html

   You can use any of the annual icecore oxygen isotope series that you want, e.g. (ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/greenland/gisp/crete/ct74-1y.txt).

   Also download the annual average temperature data for the Angmagssalik weather station from

   http://data.giss.nasa.gov/cgi-bin/gistemp/gistemp_station.py?id=431043600000&data_set=1&num_neighbors=1

   These are respectively ice core temperature proxy data for central Greenland and weather station data for coastal Greenland.

   (a) Plot the Icecore data along with a 5 year moving average.
   (b) Plot the Measured annual temperature data together with a 5 year moving average.
   (c) For those year where both icecore and measured temperature data are available, plot 5 year moving averages of both series on the same graph.
   (d) From your graph, what do you conclude about the ability of ice core data to predict short run local temperature. Explain this conclusion in the context of the reading for this week, ‘Paleoclimatology: the Oxygen Balance’.