MTMG37 Example Solution to Class Exercise 2

1. Temperatures

Note that this section is not written as a report, but only to point out some features of the data that you should have addressed. The wind-speed example in the next section gives you an idea of a report style.

The summary statistics for daily maximum temperatures are given in Table 1 and should immediately alert you to an error in the data: there is one value equal to 270°C. This occurs on day 167, immediately after two missing observations, so may be related to an instrumentation failure. Alternatively, the value may just have been stored incorrectly: perhaps the temperature has been recorded in degrees Kelvin, or maybe the decimal point is in the wrong position. The former is unlikely given the temperatures recorded on the preceding and succeeding days. In fact, I inserted the error myself (merely for demonstration purposes of course!) and the latter explanation is correct: it should be 27.0°C. The statistics after this correction has been made are shown in Table 2. Note that the mean, standard deviation and range change a lot, but the quartiles are more robust and are unaffected.

Mean	Std Dev	1st Quartile	Median	3rd Quartile	IQR	Range
16.28	15.12	10.3	15.2	20.5	10.2	272.6

Table 1. Statistics of daily maximum temperatures (°C) in 2003.

Mean	Std Dev	1st Quartile	Median	3rd Quartile	IQR	Range
15.62	6.93	10.3	15.2	20.5	10.2	36.1

Table 2. Statistics of corrected daily maximum temperatures (°C) in 2003.

Did you make any other checks on the data? One simple idea is to check for each day that the minimum temperature does not exceed the maximum temperature.

The summary statistics for daily minimum temperatures are shown in Table 3, and histograms of daily maximum and minimum temperatures, using the same axes in both plots, are given in Figures 1 and 2. Both distributions are roughly symmetric, with the mean of the minimum temperatures about 9°C lower than the mean of the maximum temperatures. The minimum temperatures also have a smaller spread (the standard deviation is about 1.5°C lower) than the maximum temperatures. Can you explain this phenomenon scientifically?

Mean	Std Dev	1st Quartile	Median	3rd Quartile	IQR	Range
6.55	5.42	2.3	6.6	10.7	8.4	26.5

Table 3. Statistics of daily minimum temperatures (°C) in 2003.

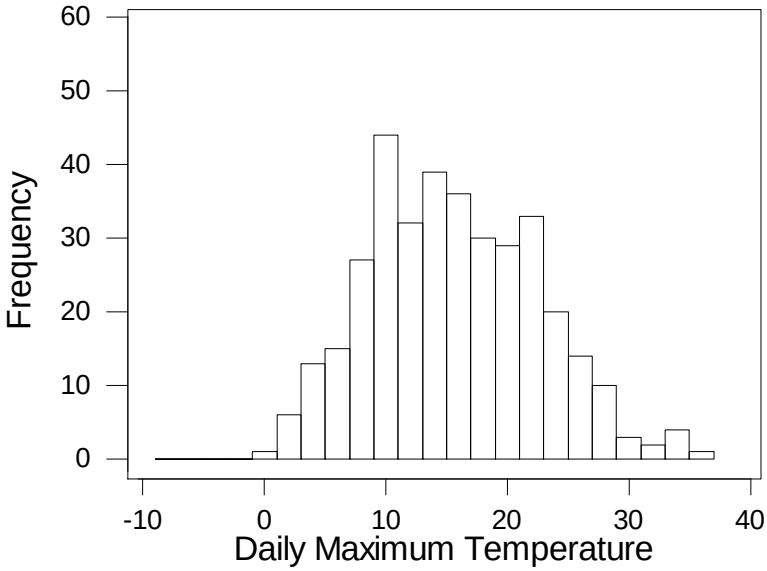

Figure 1. Histogram of daily maximum temperatures (°C) recorded in 2003.

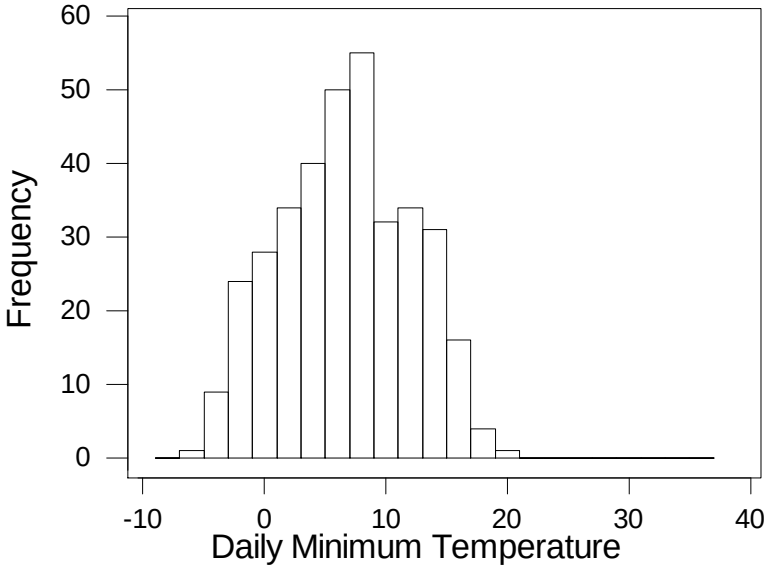

Figure 2. Histogram of daily minimum temperatures (°C) recorded in 2003.

2. Wind speeds

The 3-metre wind speeds recorded with a cup anemometer in metres per second (m/s) at the University of Reading meteorology station during 2003 will be examined. Two wind-speed measurements are available: daily means and maxima of five-minute averages. The study aims to compare the probability distributions of the wind-speeds and identify any unusual features. Observations are missing in both records for six days of the year and are omitted from the analysis. This is assumed to cause no bias in the results for reasons given in Exercise 1.

Mean wind speed equals zero for every day in the period 16 July – 29 October. It appears that the anemometer may have been broken. The wind speeds in this period, including the similarly small daily maxima, are omitted from the subsequent analysis for two reasons: the anemometer readings are probably unreliable, and the presence of a large number of zero or near-zero values can hide patterns in the remainder of the distribution.

Histograms of the remaining daily mean and maximum wind speeds are shown in Figures 3 and 4, and summary statistics are given in Table 4. Both distributions are slightly positively skewed. The mean of the daily mean wind speeds is approximately 7m/s lower that of the daily maxima, and the spread is also smaller. There is one outlying daily maximum observation of 30.1m/s that occurred on 30 October, immediately after the period of zero mean wind speeds. The mean wind speed on this day was 1.0m/s, so the maximum either corresponds to a short-lived gust or is a measurement error. The summary statistics are only slightly affected if this outlier is removed from the analysis, however, and the qualitative conclusions are unaffected.

	Mean	Std Dev	1st Quartile	Median	3rd Quartile
Mean	2.38	1.14	1.6	2.3	3.2
Maximum	9.69	3.61	7.6	9.2	11.5

Table 4. Statistics of daily mean and maximum wind speeds (m/s) in 2003.

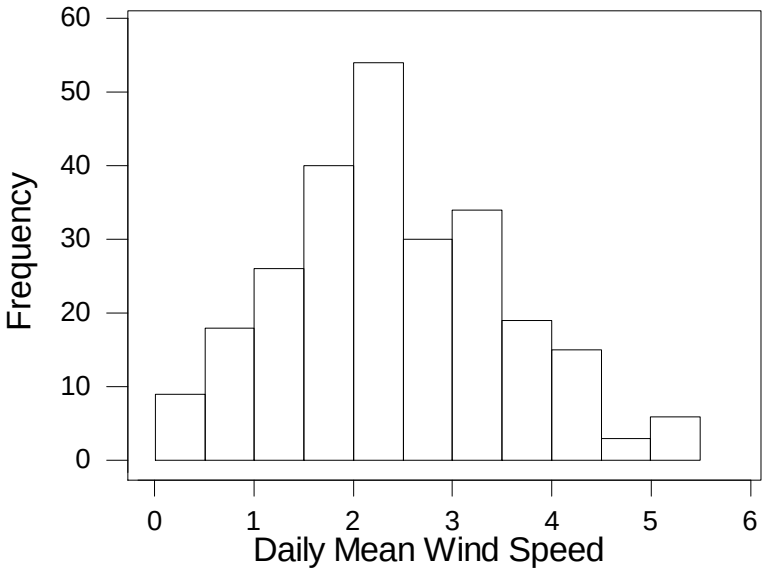

Figure 3. Histogram of daily mean wind speeds (m/s) recorded in 2003.

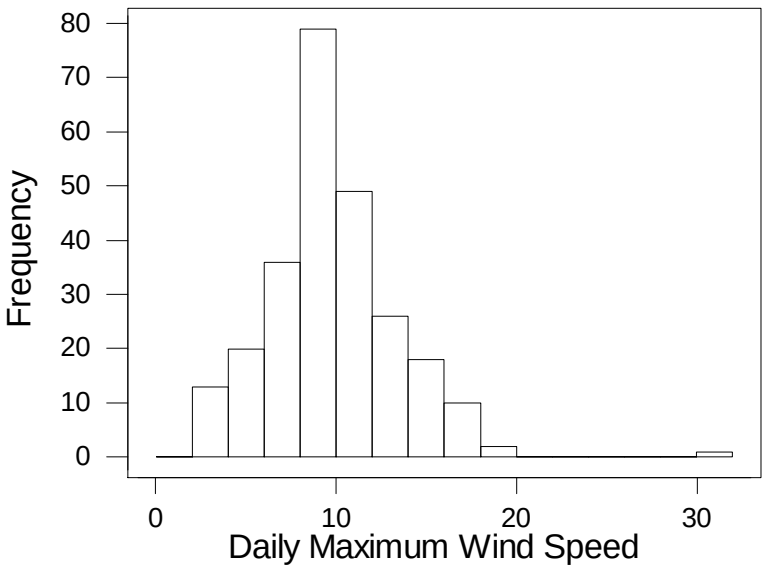

Figure 4. Histogram of daily maximum wind speeds (m/s) recorded in 2003.