“And what is the use of a book”, thought Alice,  
“without pictures or conversations?”

Lewis Carroll  
_Alice in Wonderland_

Well-chosen illustrations breathe life into a paper, giving the reader interesting visual elements to browse and highlighting the central results and ideas. A typical figure is of visual matter such as a graph or diagram, or of textual matter such as a table, algorithm, or, less commonly, complex mathematics. Some information is best presented in a pictorial form, such as a graph or figure, to show trends and relationships. Other information is best as a table, to show regularities. This chapter concerns style issues related to such material.

**Graphs**

Graphs are usually the best way to present numerical results. Numbers should be used sparingly. Instead, use graphs wherever appropriate, to elegantly summarize numbers so that the behaviour under discussion is obvious. If you must list the numbers as well, put a detailed table of results in an appendix, but in many cases the trend is the interesting outcome; the numbers are only of transient significance and can be omitted.

Don’t flood your paper with statistics, even in graphical form, and avoid repetition; each graph should convey interesting new information. It is all too easy to generate reams of numbers by running software with different combinations of parameters, but, even though these numbers may contribute to your analysis and understanding of the phenomena being observed, they are unlikely
to be of value to a reader. You should present information because it is supporting evidence for a hypothesis, not because it is an output of some program.

Graphs should be simple, with no more than a few plotted lines and a minimum of clutter. The horizontal or $x$-axis should be used for the parameter being varied, or the input; the vertical or $y$-axis is for the function of the parameter, or the output. Plotted lines of discrete data should always have points marked by distinctive marks such as circles, boxes, or triangles. Ticks or crosses are acceptable if they are easy to see.

Consider using greys and line thickness rather than dots and dashes to distinguish between lines. If you use shades of grey to distinguish different elements in the graph, ensure that the shades are sufficiently distinct; lines in lighter grey sometimes need to be a little thicker than other lines. Greys are preferable to cross-hatching, which can create the optical illusion of shimmering and does not photocopy well. Only use colour in a write-up if colour printing is used to produce the final version.

Minimize use of unnecessary elements and remove all decoration. Are the secondary ticks on the axes useful? If not, discard them. Is a legend necessary? If not, remove it, and label the lines directly. Do the captions have to be in a large font? If not, diminish them. Axes should be inconspicuous; ink should be used for data, not dressing. Gridlines and boxing are other forms of unnecessary ornamentation. Secondary marks, such as axis ticks, should be a little lighter than the other elements. The lines and other elements should be of similar weight—don’t mix a large, bold font with lightly drawn lines, for example.

Many of the commonly used graphing tools provide features that are only rarely of value; worse, some of these features are invoked by default. Poor versions of a graph are shown on page 86, with revisions of it on page 87. A slightly more complex graph is shown on page 88. See also the graphs on pages 89–92 and 95–98.

Note the shape of these graphs: rectangular rather than square, with the legends placed in spare space within the body of the graph. The legend needs to be placed where it can’t be confused with other material; default placement may mean that the legend obscures part of a curve. The emphasis is on creating as much space as possible for presentation of data, while other elements are held to a minimum.

You may need a little imagination to allow the desired picture to emerge. Logarithmic axes are useful because they show behaviour at different orders of magnitude. An example of changing to a logarithmic axis is shown on page 89. Graphs with logarithmic axes are also useful when plotting problem size against algorithm running time, as different asymptotic growth rates give straight lines.