Data display, plots and graphs

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1 Introduction

Some years ago `tex.stackexchange.com` (TeX.SE) seems to have taken over from `comp.text.tex` for asking about (LA)TEX and friends. A perennial question on TeX.SE seems to be asking what (LA)TEX is useful for apart from typesetting mathematical papers. There have been many answers to this and I would like to suggest one more: displaying data. In this note I'll mention a couple of ways that I found that LATEX could help with tables, graphs, and plots of data. The impetus for this was when I was strongly advised by my local hospital to keep a check on my blood pressure (BP).

2 Practicalities

Following the consultant's suggestion I measure my BP three times a day (morning, afternoon, and in the evening) and average them to get a reading for the day. I do this every day and it is surprising, to me at least, how it varies. I felt that I needed to keep a record of all this so I could present it to the medical experts in case of any problems (like blackouts or falling downstairs — don't ask).

I decided that I needed at least three kinds of records: a tabulation of the BP readings; a plot of the BP; and a graph of the BP.

In the following the data shown is for a hypothetical individual I have designated as Q[1] and have no relationship with any actual BP readings.

3 Tabulation

I just used the normal `table` environment with the `booktabs` package to produce a tabulation along the following lines, resulting in the example below for Q at a single day per week (Wk.).

```
% \usepackage{booktabs} % in the preamble
\begin{tabular}{lclllll} \toprule
Date & Wk. & Morn. & Aft. & Eve. & Average
                                  \\ \midrule
4/4  & 1 &         &         & 179/109 &
                                  179/109 \\
11/4 & 2 & 156/109 & 147/89  & 149/93 &
                                  150/97 \\
etc. \\
\bottomrule
\end{tabular}
```

[1] I'm a fan of the original Bond books.

Date	Wk.	Morn.	Aft.	Eve.	Average
4/4	1			179/109	179/109
11/4	2	156/109	147/89	149/93	150/97
18/4	3	158/108	142/92	146/92	149/97
etc.					

The higher readings are for the systolic (maximum) blood pressure and the lower ones for the diastolic (minimum) pressure during the heartbeat's cycle.

4 Plotting

According to the user manual for my BP monitor, the World Health Organization (WHO) have developed a BP classification scheme. I decided that it might be useful to plot the BP against this scheme as shown for the Q individual.

WHO describe 6 regions in their classification. These are: Optimal BP, Normal BP, Normal Systolic, Mild Hypertension, Moderate Hypertension, and Severe Hypertension.

I have used the standard `picture` environment for producing the plot. The only special macros that I used were

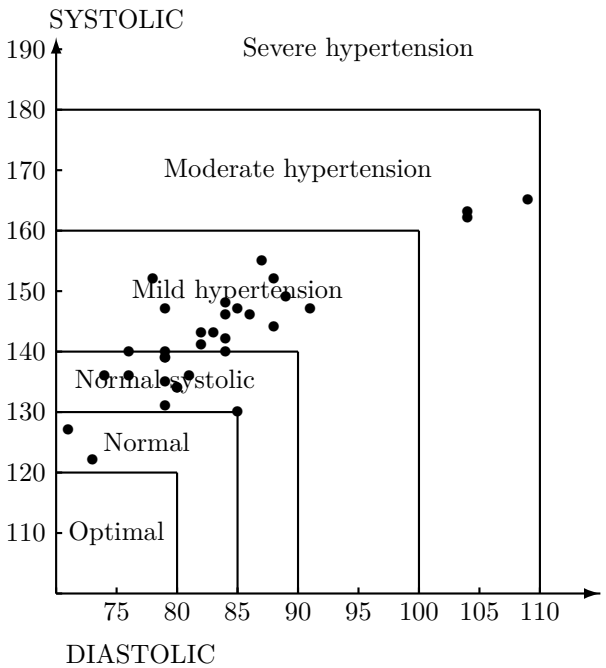
```
% bored with typing \makebox(0,0)
\newcommand{\zbox}[1]{\makebox(0,0){#1}}
% plot symbol
\newcommand*{\mk}{\zbox{$\bullet$}}
% \plotit{location}{week}
\newcommand{\plotit}[2]{\put(#1){\mk}}
```

The first two to minimise typing and the last for plotting a BP reading at the `\put` location. With `\makebox(0,0){text}` the reference point for plotting 'text' is at the center, vertically and horizontally, of `text`.

This is an outline of the code I used for the picture.

```
\setlength{\unitlength}{0.8cm}
\begin{picture}(8,11)

\thicklines

% the horizontal and vertical lines
\put(0,0){\line(1,0){9}}
\put(9,0){\vector(1,0){0}}
\put(0,0){\line(0,1){10}}
\put(0,10){\vector(0,1){0}}
\multiput(0,0)(1,0){9}{\line(0,1){0.1}}
\multiput(0,0)(0,1){10}{\line(1,0){0.1}}

% the axis labels
\put(1,10.3){\zbox{SYSTOLIC}}
\put(1.4,-1.0){\zbox{DIASTOLIC}}
\put(1,-0.3){\zbox{75}}
```

```
% etc
\put(8,-0.3){\zbox{110}}

\put(-0.5,1){\zbox{110}}
% etc
\put(-0.5,9){\zbox{190}}

% the regions
\put(0,2){\line(1,0){2}}
\put(2,0){\line(0,1){2}}
  \put(1,1){\zbox{Optimal}}
% etc
\put(0,8){\line(1,0){8}}
\put(8,0){\line(0,1){8}}
\put(4,7){\zbox{Moderate hypertension}}
\put(5,9){\zbox{Severe hypertension}}

% the BPs
\plotit{7.8,6.5}{1}
% etc
\plotit{0.8,3.6}{33}
\end{picture}

\vspace{10mm}
% caption
{\centering
\emph{Scatter plot with
      WHO classification of blood~pressure}
\vspace{\baselineskip}
\par}
```

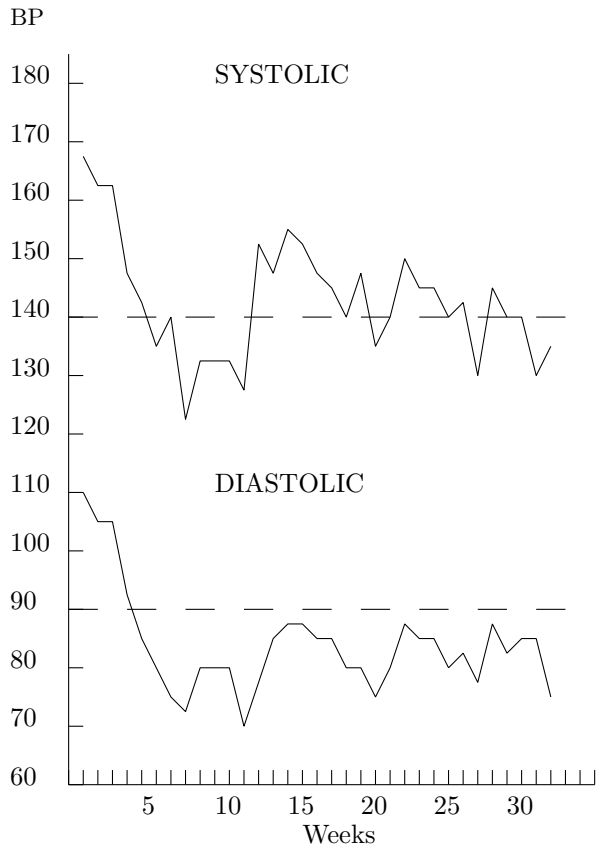


Scatter plot with WHO classification of blood pressure

The result shows that the hypothetical Q person's BP is typically in the range of Normal Systolic to Mild Hypertension but with some outliers.[2]

5 Graphing

For graphing BP I used the regular `picture` environment. Nothing special about drawing the axes. The thing of interest here is the use of the `\polyline` macro from the `curve2e` package. This takes a list of coordinates like `(x,y)` and draws straight lines between them.



Graph of blood pressure over time

Here is a brief outline of the code I used for the graph showing the use of `\polyline`.

```
\begin{center}
\setlength{\unitlength}{5.5pt}
\begin{picture}(41,81)
% draw axes, etc., then the BP graphs
% scaled to the size of the axes
% first the systolic
\polyline
```

[2] As a non-medical person I cannot comment on what this might mean for our imaginary person.

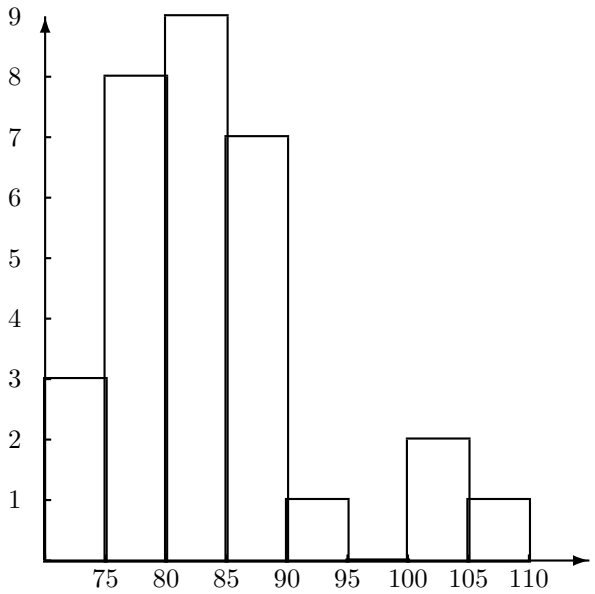
```
(6,65)(7,46)(8,46)(9,40)(10,38)(11,35)%
(12,37)(13,30)(14,34)(15,34)(16,34)(17,32)%
(18,42)(19,40)(20,43)(21,42)% etc
% then the diastolic
\polyline
(6,26)(7,23)(8,23)(9,18)(10,15)(11,13)%
(12,11)(13,10)(14,13)(15,13)(16,13)(17,9)%
(18,12)(19,15)(20,16)(21,16)% etc

\end{picture}
% caption
\emph{Graph of blood pressure over time}
\vspace{\baselineskip}
\end{center}
```

The dashed lines indicate the upper limits of the WHO Normal Systolic regime.

The graphs show that after an initial worrying period Q's BP settled down to a fairly regular pattern albeit with some fits and starts.

6 Histogram

Another way of displaying data is by a histogram which shows the number of data points noted within sets of ranges. The following is a histogram of Q's diastolic BP for 5 mg ranges.



Histogram of Q's Diastolic BP

Nothing special about the code. I used the `\framebox` macro for drawing the rectangular regions and created a macro to reduce the number of characters needed for specifying its location and size.

```
\newcommand{\histit}[2]{\put(#1,0.0)%
    {\framebox(1,#2){}}}
```

where the first argument is the x location of the framebox and the second is its height.

I must say that I found the scatter plot more informative than the histogram, although the latter highlighted the unusual high diastolic readings.

7 Summary

I have shown four different ways of displaying data. Edward Tufte[3] has shown many other ways.

There are many applications for (LA)TEX and friends. Among those noted on TeX.SE, apart from mathematical and scientific publications, are:

Books fiction and non-fiction

Correspondence

Games Bridge, Chess, Crosswords, Noughts and Crosses (aka Tic-tac-toe), Sudoku

Greeting cards

Invoices

Literature Critical editions, Multilingual

Mars Rover (programmed via TEX)

Music

Newsletters

Poetry

Postcards

Presentations (slides)

. . .

I hope that my small application might give thoughts towards suitable additions to the above list.

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[3] Edward R. Tufte, *The Visual Display of Quantitative Information*, Graphics Press, 1983.