Generating Charts with **FAST\textsc{PÍCTEX}**

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Dedicated to
the Free Software Foundation
and all \TeX users
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Chapter 1

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Chapter 2

Introduction

When I was writing my doctoral thesis in the late 80\textsuperscript{th}, I spent my total savings and bought an IBM-compatible personal computer, that was based on a 8080 microprocessor. Of course, I was using \LaTeX as text-processing software. Inspired by my brother Bernhard, I decided to use \PCTeX to generate the charts for my thesis. However, I soon recognized that the \TeX version that I used at this time (\PCTeX) was not suitable to generate \PCTeX charts, since I very often received messages, such as:

\begin{verbatim}
! TeX capacity exceeded, sorry [main memory size = 65536 bytes]
\end{verbatim}

Finally, the excellent \TeX implementation from Eberhard Mattes appeared and I could use Big\TeX to generate my theses using the MS-DOS operating system. Later, I switched to the Linux operating system that came with the \TeX implementation and memory management was no longer a limitation. Today, I am using the Mik\TeX implementation of \TeX on the MS-Windows Vista operating system. The old original files of my doctoral thesis still run smoothly through Mik\TeX without modifications and that is 20 years after the thesis was written.

However, the use of \PCTeX for generating charts is still quite time consuming, because the \PCTeX macro language, although very powerful, is somewhat awkward. Pictures must be described by the \PCTeX programming language and usually a lot of debugging is necessary to obtain the desired result. This may be the largest disadvantage of \PCTeX. Otherwise, \PCTeX is very advanced and offers nearly everything necessary to generate very nice charts of scientific data material. In order to overcome the time consuming part of generating the \PCTeX code, I decided to write a \PCTeX-preprocessor that does all the nasty part in generating \PCTeX code. This preprocessor takes a very simple macro file as input and generates an output file containing the \PCTeX code. The output file can then be included in a document by the \texttt{\input} command. As with most preprocessors there are
some limitations of FASTP\LaTeX{}E. First, only numerical diagrams based on data material can be generated. Second, only a limited set of commands are implemented, offering only basic instructions. Therefore, fine tuning the \LaTeX{}E code is usually still necessary. However, a working skeleton of the \LaTeX{}E file can be generated easily by FASTP\LaTeX{}E.
Chapter 3

Installation and Usage

To use FASTP\TeX \textnormal{E}X you certainly need \TeX. \TeX was developed by Donald E. Knuth. His \TeXbook [1] is the basis of all packages based on the most advanced typesetting software available for almost any computer platform. In addition to \TeX you also need \La\TeX that was developed as an extension to \TeX by Leslie Lamport who has written the original \La\TeX manual [2]. In addition, you need Pt\CTeX that is described in [3]. The Pt\CTeX manual by the author of Pt\CTeX, Michael J. Wichura, is an in-depth description of the Pt\CTeX system and is certainly worth to read. The Pt\CTeX manual used to be freely available on the Internet. Currently, it is only available for purchase.

Installation of FASTP\CTeX is as simple as unpacking the archive, and running make. A binary executable version of FASTP\CTeX for the MS-DOS/Windows operating system is included. Compilation of the program for other operating systems should be straightforward with any standard C++ compiler (I have used the MinGW Compiler).

\begin{verbatim}
tar -xzvf fastpictex-x.y.tar.gz
cd fastpictex-x.y/src
make
\end{verbatim}

Once you have generated the executable, you are ready to generate Pt\CTeX code in just a few seconds. fastpictex is a command line program that accepts two parameters: the input file name and the output file name. The input file is a FASTP\CTeX macro file, while the output file is the Pt\CTeX code that can be included in a \La\TeX document. Thus, running FASTP\CTeX is as simple as typing:

\begin{verbatim}
fastpictex file_in file_out
\end{verbatim}

As an example, consider the very simple input file (bargraph.fpt) that generates a bargraph with four columns and standard-error bars:
Figure 3.1: This bargraph was produced by \textsc{FastPictex} by only four lines of input code.

\begin{verbatim}
type bar
  x
  y 13 14 18 24"*"
  dy 1.5 1.9 2.4 5.2
\end{verbatim}

To generate a P\TeX file that can be included in any L\TeX file (the P\TeX package must be included) run the command:

```
fastpictex bargraph.fpt bargraph.ltx
```

A L\TeX document that includes the bargraph (see Fig. 3.1) generated by \textsc{FastPictex} could be:

```
\documentclass[12pt]{book}
\usepackage{pictex}
\begin{document}
This is a pretty nice bar graph: \\n\input bargraph.ltx
\end{document}
```
Chapter 4

The macro language

The FAST\LaTeX macro language consists of a few commands that can be used to design a chart. The series of commands that compose a chart are generally written to a file using a text editor, such as emacs or vi. A command always starts in the first column of a line. Following the command word at least one whitespace character must be inserted before the parameters for the command are added. The parameters for the commands are also separated by whitespace characters and can continue in subsequent lines. However, if several lines are used for one command, then the subsequent lines must start with at least one whitespace character (instead of with a command word).

As an example, consider the following macro for the line graph shown in Fig. 4.1:

\begin{verbatim}
type line
x  1 2 3 4 5
    6 7 8 9 10
y  95 100 110 95 105
    110 120 125 145 160
\end{verbatim}

In this example, the x and y commands are spread over two lines. Note, that the second lines for these commands start with whitespace characters. Whitespace characters can be blanks or tabulators.

It is also possible to design charts with more than one series of data. For each series of data, commands must be provided as demonstrated in the next example. The example consists of three series of xy charts. The resulting chart is shown in Fig. 4.2. Note, that the three data series are automatically distinguished by different symbols (i.e. by filled circles, open circles, and by diamonds).

\begin{verbatim}
type xy
\end{verbatim}
In addition, it is possible to combine different graph types in one chart. Consider an example, in which the data points of an XY-Graph should be connected by lines. A macro file for such a chart composition is shown in the next example (Fig. 4.3).

```
type xy
x  3.4 5.4 7.5 9.3 12.5
y  12 23 45 32 83 23


type xy
x  1.2 4.5 6.5 6.9
y  4 11 74 62


type xy
x  3.4 5.5 7.8 9.2 10.2 11.8
y  2 3 8 20 18 37
```
Figure 4.2: A XY-graph with three series.

Figure 4.3: A graph with different chart types.
If a chart that consists of several series is to be composed, it is important to understand, how \textsc{Fast\TeX} handles the order of the commands. If a command word occurs for the first time, the command belongs to the first series. If the command word appears for a second or third time, it belongs to the second or third series. Therefore, the example that generated Fig. 4.3 could have also been written as:

```latex
\begin{verbatim}
type xy
type line
x  1  2  3  4  5
x  1  2  3  4  5
y  9 12 15 17 19
y  9 12 15 17 19
dx 0.5 0.6 0.4 0.5 0.7
dy 0.8 0.9 1.2 2.0 2.4
\end{verbatim}
```

In the following sections of this chapter, the various commands are described in detail. For each command, examples are given as to how to use the commands.

### 4.1 Comments, the \% command

To add comments, use the command word \%. As an example, the macro code for one of the former examples (Fig 4.3) can be written as:

```latex
\begin{verbatim}
% first, the XY-Graph with 5 data points
type xy
x  1  2  3  4  5
y  9 12 15 17 19
% there are standard errors for the x and y-values
dx 0.5 0.6 0.4 0.5 0.7
dy 0.8 0.9 1.2 2.0 2.4
% here comes the line graph
type line
x  1  2  3  4  5
y  9 12 15 17 19
\end{verbatim}
```

### 4.2 The size command

The size command allows to define the width and height of the plot. The parameters of the size command are the width and the height of the chart.
which must both be given in units of centimeters (cm). If no size command is given, the width and height both default to 6 cm. The output of the following example is shown in figure 4.4.

```
size 10 5
type bar
x
y 43 56 34 67 98
dy 4 5 4 7 10
type bar
x
y 21 23 12 29 50
dy 2 3 1 2.5 4.3
```

4.3 The type command

The type command defines what kind of chart should be generated. The available chart types are:

- XY-graphs
- line graphs
- bar graphs
CHAPTER 4. THE MACRO LANGUAGE

Please keep in mind, that you must enter a type command for every series in your chart. It is not possible to define the chart type once for all series!

4.3.1 XY-Graphs

To generate a XY-graph, simply use “type xy”. An example is given in Fig. 4.2. With XY-graphs it is sometimes interesting to study the correlation between the two variables X and Y. With FASTPICTEX this can be accomplished by the “tline” command explained later.

4.3.2 Line-Graphs

To generate a line-graph, use “type line”. An example is given in Fig. 4.1.

4.3.3 Bar-Graphs

To generate a bar-graph, use the command “type bar”. An example is given in Fig. 3.1. The x-coordinates of bar-graphs always start at 1 and increase by steps of 1. Therefore, the x command for a bar graph may consist of only the letter x and no actual x-coordinates.

4.4 The tline command - Regression lines

The “tline” command generates regression lines and the linear regression equation for XY-graphs. The “tline” command is followed by a parameter that can be 0, 1, or 2. A parameter of 0 is equivalent to not type the “tline” command at all.

\texttt{tline 0} no regression line and no linear regression equation.
\texttt{tline 1} regression line but no linear regression equation.
\texttt{tline 2} regression line and linear regression equation.

Below is the FASTPICTEX code of a small example with regression lines. The corresponding graph is shown in Fig. 4.5. Please note that the linear regression equation is only printed for the second XY-graph because the parameter for the \texttt{tline} command for the first XY-graph is “1”.

\texttt{type xy}
\texttt{x 1 2 3 4}
4.4. THE TLINE COMMAND - REGRESSION LINES

\begin{verbatim}
y 12 24 29 45
tline 1
type xy
x 0.8 2.2 2.9 3.5 4.2
y 19 37 56 62 76
tline 2
\end{verbatim}

\begin{figure}
\centering
\begin{tikzpicture}
\begin{axis}[
width=\textwidth,
height=\textwidth,
view={0}{90},
]
\addplot+[only marks] coordinates {
(0.8,19) (2.2,37) (2.9,56) (3.5,62) (4.2,76)
};
\addplot+[only marks,dotted] coordinates {
(2.2,19) (2.9,37) (3.5,56) (4.2,62)
};
\end{axis}
\end{tikzpicture}
\caption{A small example with regression lines.}
\end{figure}

A more complex example of a FASTPICTEX file with regression lines is shown below and the corresponding graph is provided in Fig. 4.6. The \begin{sideways} ... \end{sideways} environment used in this example requires the rotating package.

\begin{verbatim}
\% ...... start of FastPicTeX file generated by WinStat ......
size 8 6
heading VLF$_{SYS}$ BPV depends on BP$_{SYS}$
xlabel BP$_{SYS}$ (mmHg)
ylabel \begin{sideways}VLF$_{SYS}$ BPV (mmHg$^2$)\end{sideways}
type xy
x 125.893 122.068 129.876 137.412 118.674 113.696 125.006 125.461
  129.847 118.953 108.51 121.579 119.482 98.8476 142.496 164.389
  123.95 115.166 132.47 144.27 133.035 133.055 154.599 122.92
  128.499 113.579 131.072 162.442 133.192
y 3.16042 8.83067 4.33801 4.30591 5.64648 2.07347 3.18186
\end{verbatim}

$y = 16.971x + 3.839, r^2 = 0.984$
4.5 The x command

The x command is used to define the x-coordinates. A x command is required for every series in a chart. However, the actual x coordinates may be omitted (i.e. the x command consists of only the letter x). In this case the x-values
VLF_{SYS} BPV depends on BP_{SYS}

Figure 4.6: A complex example with regression lines. The legend was moved from the right side of the figure to the bottom by editing the \LaTeX file of the diagram.
are assumed to start at 1 and increase by steps of 1. For example, consider the following graph that is composed of bar, line, and xy series (Fig. 4.7):

```
size 9 5
type bar
  x
  y 105 155 115 85
dy 10 12 9 8

type bar
  x
  y 165 210 150 130
dy 17 20 18 12

type bar
  x
  y 120 175 135 95
dy 12 16 11 8

type line
  x
  y 200 250 180 160
dy 13 16 9 8

type xy
  x
  y 200 250 180 160
```

The bars and lines of the resulting graph (Fig. 4.7) have their x-coordinates at 1, 2, 3, and 4. These x-coordinates are automatically defined by FASTPICTEX.

### 4.6 The xticlabels command

The xticlabels command allows to define labels for the tics at the x-axis. Examples are given in Fig. 4.8 that were created by the FASTPCTEX commands:

```
size 10 4
type bar
  x
  y 12 23 45 32
dy 1.2 2.5 5.3 4.8

type bar
  x
  y 65 34 12 85
```
4.7. THE Y COMMAND

The y command is used to define the y-coordinates. This command is required for every series in a graph. It is possible to add a string (enclosed in quotes) as labels, as shown in the example below:

```plaintext
dy 6.5 5.3 2.1 9.6
xticlabels Germany "Un. Kingd." Sweden France

and

dy 1.3 6.3 2.6 3.8
```

If the labels contain blanks, you may enclose the entire label in quotes as demonstrated in one of the examples. One limitation is that it is not possible to use \LaTeX formatting commands such as \textbf{bf} or \textit{it} in `xticlabels`.

4.7. The y command

The y command is used to define the y-coordinates. This command is required for every series in a graph. It is possible to add a string (enclosed in quotes) as labels, as shown in the example below:

```plaintext
dy 6.5 5.3 2.1 9.6
xticlabels Germany "Un. Kingd." Sweden France

and

dy 1.3 6.3 2.6 3.8
```

If the labels contain blanks, you may enclose the entire label in quotes as demonstrated in one of the examples. One limitation is that it is not possible to use \LaTeX formatting commands such as \textbf{bf} or \textit{it} in `xticlabels`. 
Figure 4.8: Examples with labels at the tics of the x-axis.
4.8. THE DX COMMAND

double quotes) directly (without any whitespace) after the numbers for the y-values. This string will be printed on top of the data point in the chart. This feature allows to add asterisks to indicate that this data point is significant or to add other kind of information to a specific data point. Examples are given in Fig. 3.1, 4.9, and 4.13. The latter one was produced by the following \LaTeX{} commands:

```latex
size 10 4
type bar
x
y 12 23 45"$\dag$" 32
dy 1.2 2.5 5.3 4.8
type bar
x
y 65"*" 34"n.sig." 12"*" 85"*"
dy 6.5 5.3 2.1 9.6
```

4.8 The dx command

The dx command can be used to define error bars in x-direction. For example, if the standard errors are given, \LaTeX{} draws horizontal error bars extending to the left and to the right by ± the standard errors. An example is given in Fig. 4.3.
4.9 The dy command

The dy command can be used to define error bars in y-direction. For example, if the standard errors are given, \texttt{FastPicTeX} draws vertical error bars extending up- and downwards by $\pm$ the standard errors. Examples are given in Figs. 3.1, 4.3, and 4.7.

4.10 The heading command

The heading command can be used to define a heading for a chart. The heading is placed above the chart. Standard \TeX formatting commands can be used as illustrated in the example given in Fig. 4.10.

% FastPicTeX input file
% 3 line graphs and 3 x-y graphs
heading \textbf{A chart plotted with \texttt{FastPicTeX}}
type line
x 1 2 3 4 5 6 7 8 9 10
y 89 94 103 120 150 180 176 187 167 178
dy 9 11 13 8 14 9 12 11 10 13
type line
x 1 2 3 4 5 6 7 8 9 10
y 69 74 83 100 130 160 156 167 147 158
dy 9 11 13 8 14 9 12 11 10 13
type line
x 1 2 3 4 5 6 7 8 9 10
y 49 54 63 80 110 140 136 147 127 138
dy 9 11 13 8 14 9 12 11 10 13
type xy
x 1 2 3 4 5 6 7 8 9 10
y 89 94 103 120 150 180 176 187 167 178
type xy
x 1 2 3 4 5 6 7 8 9 10
y 69 74 83 100 130 160 156 167 147 158
type xy
x 1 2 3 4 5 6 7 8 9 10
y 49 54 63 80 110 140 136 147 127 138
4.11 The xlabel and ylabel commands

These two commands can be used to enter a label to the x- and y-axis. Like in the heading command, regular \LaTeX formatting instructions can be included. If the y-axis label should be rotated by 90°, the command \texttt{\rotatebox{}{}} can be used. This command is included in the graphics package distributed with most \TeX and \LaTeX distributions. However, the \texttt{\rotatebox{}{}} command uses special commands that can only be handled by some DVI-drivers, such as the DVIPS driver. Another alternative is the rotating package that offers the \texttt{\begin{sideways} ... \end{sideways}} environment that has been used to generate Fig. 4.6. An example using the \texttt{\stack{}} command to write the y-axis label vertically is shown in the next Figure (Fig. 4.11).

heading \texttt{\bf Blood Pressure With Increasing Age}
xlabel time (years)
ylabel \texttt{\stack{b,l,o,o,d,,,,p,r,e,s,s,u,r,e}}
type line
x 25 30 35 40 45 50 60 70 80 90
y 120 135 156 165 175 190 203"*" 196"*" 210"*" 203"*"
dy 12 13 15 16 17 19 20 20 21 18
type xy

Figure 4.10: A chart with a heading.
Blood Pressure With Increasing Age

![](chart.png)

Figure 4.11: A chart with a heading and labels at the axis.

| x  | 25 30 35 40 45 50 60 70 80 90 |
| y  | 120 135 156 165 175 190 203 196 210 203 |

### 4.12 The xgrid and ygrid commands

If these commands are given, gridlines will be drawn in the x or y direction respectively. The commands do not need any parameters. If the xgrid or ygrid commands are not given, no gridlines will be drawn. An example is given in Fig. 4.12 that was generated by the following commands:

```
type xy
heading A graph with grid lines
xgrid
x 123 234 196 349 453 98 294
dx 12 34 23 32 12 7.5 11.2
ygrid
y 12 65 84 47 23 91 17
dy 1.4 4.6 7.3 6.2 4.1 11.6 7.5
```
4.13 The legend command

If several series of data are plotted in one single diagram, one need to know which series represents which data. To add a legend to a series simply use: "legend description of data series". An example is given in Fig. 4.13 that was generated by the following FASTPICTEX file:

```plaintext
% Example for using legends
size 6.5 6
heading \bf VLF blood pressure variability
xlabel Weeks on high-salt diet
ylabel mmHg$^2$

% SHR-SP
legend SHR-SP, n=34
type bar
xticlabels 3-5 6-7
x 1 2
y 14.317 16.040
dy 1.549 1.942
% SHR-SR
legend SHR-SR, n=37
type bar
x 1 2
```

Figure 4.12: A chart with grid lines.
CHAPTER 4. THE MACRO LANGUAGE

VLF blood pressure variability

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure4.13.png}
\caption{An example with legends.}
\end{figure}

\begin{verbatim}
y 12.850 19.608"**"
dy 1.390 1.935
% NT-WKY
legend NT-WKY, n=27
type bar
x 1 2
y 6.374 8.466
dy 1.026 1.031
\end{verbatim}

4.14 The pictex command

Text following the \texttt{pictex} command is simply copied into the \texttt{pictex} file to be interpreted by \texttt{PCTeX}. This command allows adding plain \texttt{PCTeX} instructions to \texttt{FASTPCTeX} files. The syntax for this command is not very complex: \texttt{"pictex whatever you want to pass on to pictex"}. An example is provided in Fig. 4.14 that was generated by the following \texttt{FASTPCTeX} code:

\begin{verbatim}
% example showing the use of pictex commands
size 5 3
\end{verbatim}
heading Blood pressure on 5 consecutive days
xlabel Days
ylabel mmHg
\% xy graph for male subjects
\texttt{type xy}
\texttt{xticlabels 1 2 3 4 5}
x 1 2 3 4 5
y 105 96 150 87 98
dy 10 9 13 5 7
legend male subjects, n=9
\% xy graph for female subjects
\texttt{type xy}
x 1 2 3 4 5
y 85 92 80 95 90
dy 7 8 9 10 7
legend female subjects, n=7
\% line graph for male subjects
\texttt{type line}
x 1 2 3 4 5
y 105 96 150 87 98
\% line graph for female subjects
\texttt{type line}
x 1 2 3 4 5
y 85 92 80 95 90
\% here are the pictex commands
\texttt{pictex \arrow <3mm> [0.2,0.67] from 3.5 160 to 3.1 150}
\texttt{pictex \put \{artifact\} [lc] at 3.6 160}
Blood pressure on 5 consecutive days

- male subjects, n=9
- female subjects, n=7

**Figure 4.14:** \textsc{PCTEX} commands included in \textsc{FastPCTEX}. 
Bibliography

