

Boxes and more boxes

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Abstract

Boxes are a key concept in \LaTeX as well as an useful tool, though not a very well known one. I believe this is due to the success of \LaTeX in providing a high level interface to \TeX , which allows the user to produce beautiful documents without getting acquainted with the concept of boxes. But it is useful to know the box concept because it enhances our understanding of \TeX , helps us to avoid and solve problems and can even propose solutions for unusual circumstances.

In this paper we reproduce, step by step, the reflection effect in the title of this article in order to gain some knowledge of the box concept.

1 Box basics

Among the fundamental ingredients of a \LaTeX document, there are *boxes*: imaginary rectangles which enclose letters, lines, pages, paragraphs, figures, tables etc. Indeed, \TeX does not typeset letters or characters, lines ... but boxes!

You may have already used boxes to avoid breaking some word or maybe to frame an equation. But they are far more useful than this. A simple but instructive example is the reflection effect in the title of this paper, which requires one customized box. Let's learn something about it.

Figure 1 shows the box associated with the letter **g**. It has three dimensions: *height*, *width* and *depth*. It is these dimensions that \LaTeX actually cares about, not the content of the box. In other words, \LaTeX does not “see” the letter **g**, only its box. This is the important fact to understand.

We can ask \LaTeX to show us this box: just write `\framebox{g}`. Well, first we must set `\fboxsep` to zero, in order to remove the extra space around **g**: `\setlength{\fboxsep}{0in}`.

Much more important than just showing the box, `\framebox` builds a box with whatever you want inside it. For instance, `\framebox{Boxes}`. Now, **Boxes** is a *single* box, as unbreakable as the letter **g** itself. By the way, this is another property to keep in mind: *boxes cannot be broken*.

Another interesting property is this: *the contents of a box need not lie inside it*. You may have noticed that, given the contents as an argument, the `\framebox` command sets the dimensions of the box to those of the contents (in reality, to the “sub-boxes” that compose the contents). But you can define the dimensions explicitly as well. For example,

```
\framebox[.67in]{Boxes}
```

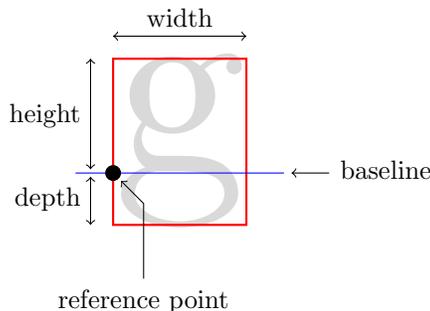
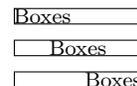


Figure 1: The dimensions of a box. Everything that is visible in a document produced by \LaTeX is in one or more boxes, which is why they are so fundamental.

produces `\framebox[.67in]{Boxes}`, a box $\frac{2}{3}$ in wide. That is, a box which occupies more space than its contents. You can also define the alignment of the content with the box, to the left, center or right, as shown below:

- `\framebox[.67in][l]{Boxes}`
- `\framebox[.67in][c]{Boxes}`
- `\framebox[.67in][r]{Boxes}`



In a similar fashion, we may create a box which occupies less space than its contents; a zero-width box, for instance:

```
\framebox[0in][l]{Boxes}
```

Try it yourself and see that **Boxes** overlaps the text at its right. This happens because, as we have seen, \LaTeX uses the dimensions of the letters (boxes) to place them side by side in a row. However, the box we have just created occupies no (horizontal) space. It looks like it is not there, though its contents are (try also changing the alignment parameter).

2 Reflecting, scaling, coloring

Another command we will need to produce the reflection effect is `\scalebox`, defined in the package `graphicx`. Its syntax is `\scalebox{f_x}[f_y]{a box}`. It changes the dimensions of the box *and its contents* according to the horizontal and vertical scaling factors f_x and f_y (respectively) and creates a new box that encloses this new content. Thus, as a first step toward our goal, to get **Boxe₂Boxes** we write

```
\scalebox{1}[-1]{Boxes}Boxes
```



This means we instruct \LaTeX to multiply the width by $f_x = 1$ (hence, nothing changes on the horizontal) and the height (> 0 in our case) and the depth ($= 0$) by $f_y = -1$. As a result, we have a vertical reflection of **Boxes**. A hint: the commands defined by `graphicx` receive boxes as arguments, not just figures (which are boxes too). Since the package was designed to handle figures, it is common to think

that its commands apply only to figures, but this is not true.

Let's proceed. How can we place `\Boxes` below `\Boxes`? Answer: by constructing it in a way that occupies no horizontal space, that is, by putting it in a zero-width box (new code in black, previous code in gray):

```
\makebox[0in]{\scalebox{1}{\Boxes}}Boxes
```

We have also swapped `\framebox` for `\makebox`. These two commands are equivalent, except that the former draws a frame around the box, while the latter does not.

Finally, we choose the reflection color (use the package `xcolor`):

```
\makebox[0in]{\scalebox{1}{\textcolor{red!80}{\Boxes}}}
```

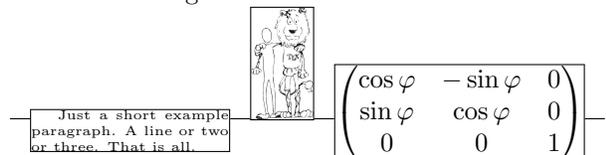
The sequence below illustrates the changing of the box width, from its *natural width* (defined by the content) down to zero. Notice that the non-inverted `\Boxes` always starts immediately after the frame (the box), not after the content (`\Boxes`).

```
\Boxes Boxes    \Boxes Boxes    \Boxes Boxes    \Boxes Boxes
```

3 Boxes upon boxes

There are boxes far more complex than these. As I mentioned, everything that is visible in a document produced by \LaTeX is in one or more boxes. There are even invisible elements in your document that are boxes too. An example is the paragraph indentation, which is nothing more than an empty box of width `\parindent`. In all cases, all of the concepts we have just seen remain valid.

Let's see an example. The line below contains three boxes plus some filling lines (which are boxes too): the first is an entire paragraph, the second is a figure and the third a mathematical table (or matrix, if you prefer). All of them have height, width and depth, are unbreakable, and are placed side by side with their *reference points* aligned (fig. 1) over an imaginary line called the *baseline*, represented by the horizontal filling lines.

baseline → 

The paragraph box is aligned on the baseline of its first line. The figure, on the other hand, inserted with the `\includegraphics` command (package `graphicx`), has depth zero (but since we've enclosed it in an `\fbox` for the example, it is not quite

zero here). Finally, the matrix has unequal height and depth (it's centered on the math axis; the \LaTeX code that produces this line is at the end of this paper). The important thing here is to notice that **the placement of all these boxes follow exactly the same rules as those followed by letters**, since they are all in boxes.

So, whenever you insert a figure or table in your document, see them as “big g letters”. In other words, *see the boxes!*

4 Further reading

To learn more about this subject, you can study the environment `minipage`, the commands `\parbox`, `\raisebox` and `\rule` in section 4.7 of [1] and/or appendix A.2 of [2]. Chapter 11 of [3] is mandatory. Moreover, have a look at the commands defined by the package `graphicx`.

Appendix: Our unusual line of text

The code used to produce the unusual text line discussed above in this paper is shown below. You will need the packages `graphicx` and `amsmath` to run it.

```
\setlength\fbxsep{0pt}\noindent\hrulefill
\fbx{\begin{minipage}[t]{0.16\textwidth}
  \setlength{\parindent}{1em}
  \tiny Just a short example paragraph.
  A line or two or three. That is all.
\end{minipage}}%
\hrulefill
\fbx{%
  \includegraphics[width=0.05\textwidth]{img}}%
\hrulefill
\fbx{\left(\begin{matrix}
  \cos\varphi & -\sin\varphi & 0 \\
  \sin\varphi & \cos\varphi & 0 \\
  0 & 0 & 1
\end{matrix}\right)}%
\hrulefill
```

Acknowledgments

The author thanks Karl Berry and Barbara Beeton for invaluable help and improvements to this article.

References

- [1] H. Kopka and P. W. Daly. *A Guide to \LaTeX* . Addison-Wesley, 3rd edition, 2004.
- [2] F. Mittelbach and M. Goossens. *The \LaTeX Companion*. Addison-Wesley, 2nd edition, 2004.
- [3] D. E. Knuth. *The \TeX book*. Addison-Wesley, 1984.

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