Some misunderstood or unknown LaTeX 2_ε tricks (VIII) and Turing-completeness

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1 Introduction

We will begin by exposing new tricks, i.e. how to

1. write 'closed' square roots,
2. insert blank pages,
3. ask the reader to turn the page,
4. write bold words in an index,
5. divide a cell by a diagonal,
6. draw 'product integrals,'
7. understand what happens when `\mathcal` has a lower-case letter argument.

We will then consider an uncommon example of what one can do with LaTeX, in link with its Turing completeness.

2 New square root

When writing square roots, some people like to 'close' the roots over their content. This way it will look clearer what is inside the square root and what is not. This habit is generally not used while writing with the computer because the text is supposed to be clear anyway, but if you still want to change the output of the square root, LaTeX gives you this possibility. Just add the following code in the preamble:

```
\let\oldsqrt\sqrt
\def\sqrt{\mathpalette\DHLhksqrt}
\def\DHLhksqrt#1#2{%
\setbox0=\hbox{$#1\oldsqrt{#2\,}$}%
\dimen0=\ht0
\advance\dimen0-0.2\ht0
\setbox2=\hbox{\vrule height%
\ht0 depth -\dimen0}%
{\box0\lower0.4pt\box2}}
```

This code is only valid for square roots, i.e. you can only use `\sqrt{a}` with this code, not `\sqrt[b]{a}`. You can then check the difference: compare

$$\sqrt{a} \quad \text{to} \quad \sqrt{a}. \tag{1}$$

[5]

3 Blank-wanted pages

If you need to create an artificial blank page, you need to put something into it so that LaTeX takes it into account. For this, you can e.g. use [1]

```
% text
\newpage
\mbox{}
\newpage
```

This might be interesting if you need to meet some specific criteria for e.g. a report.

4 Turning the page: the `turnthepage` package

On some examination sheets, some professors or lecturers like to indicate to the reader that the 'page' can be turned. That avoids oversights to the student, thereby avoiding them cold sweat at the end of the exam, realizing that there were other questions they needed to answer. (This happens more frequently than you might imagine!)

One might implement a LaTeX mechanism so that each odd page (except the last one, if it is odd) displays a message to turn the page. This mechanism can also be useful for different kinds of documents. This package can thus e.g. be used for exams, or special documents printed 'twoside.'

To *load the package*, please use

```
\usepackage[options]{turnthepage}
```

The *following options are available*:

- `short`: will display '/...' at the bottom of each odd page, in its right corner,
- `english`: will display '*Turn the page.*' at the bottom of each odd page, in its right corner,
- `francais`: will display '*Tournez la page.*' at the bottom of each odd page, in its right corner,
- `nederlands`: will display '*Sla de pagina om.*' at the bottom of each odd page, in its right corner,
- `deutsch`: will display '*Bitte wenden.*' at the bottom of each odd page, in its right corner,

As the package calls `\turnthepage` where it needs to be placed, you can define `\turnthepage` as you want. For example, if you want a more polite way to say it, you can use

```
\renewcommand{\turnthepage}{%
\itshape Turn the page please.}
```

after the preamble.

Thanks to Marc van Dongen [10] for his help about this package. It inaugurated in some way year 2011 by –I hope– 'turning the page' to better things! Thanks go to Mr. Philipp Stephani too, who found a page numbering style bug and solved this issue (through a personal communication) [8].

5 Bold index numbers

In large books, especially physics' books, some words are often used through all the book. Indexing every instance of the word thus produces an important number of pages for each word.

This is interesting, but there should normally be a place in the book where the word is explained, defined, or at least discussed in a more thoroughly fashion than elsewhere.

This place needs to be referrenced too in the index, but it is important for the reader to distinguish it from simple citations.

A good technique which is generally used is to put in bold style this number. Assuming you are using the `makeidx` package, this can be achieved using

```
\index{TUGboat|textbf}
```

where, here, `TUGboat` is our index word, and where `textbf` evidently means that the related page number will be printed in bold in the index part of the book. Thanks to Peter Flynn for this trick [3].

6 Dividing a cell by a diagonal

To divide a cell by a diagonal, you can use the `slashbox` package. Using the

```
\backslashbox{Word 1}{Word 2}
```

command, you will create a cell with 'Word 1' and 'Word 2' as diagonal elements. [4]

7 Product integrals

It might happen for you to need to draw 'product integrals.' Consider having a look at [2] for this (Richard D. Gill's home page). You can then draw the product integral symbol, as illustrated in the right bottom corner of Figure 1.

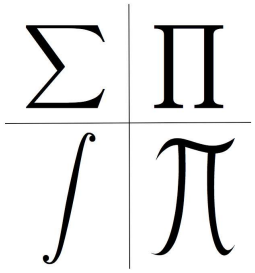

Figure 1: Four mathematical symbols, the one at the right bottom corner being defined as the 'product integral' symbol.

8 Small `mathcal` letters

When you give a lower-case letter as the argument of `\mathcal`, you generally end up with a non-letter symbol, and not a small calligraphic letter. However, `\mathcal` is known to produce calligraphic letters when its argument is an upper-case letter.

I found an explanation of this fact at [7]. I here give it, somewhat remodified. TEX was created long before character sets and fonts were standardized by Unicode and OpenType. Each mathematical font contains only 128 glyphs ("newer" versions of TEX allow 256 glyphs, but the Computer Modern math fonts use only 128).

For Latin letters, the default font is `cmmi` (Computer Modern Math Italic) which contains uppercase and lowercase letters; the `\mathcal` command simply switches all letters to `cmsy` (Computer Modern Math Symbols), which happens to contain calligraphic uppercase letters at the correct positions, but no lowercase calligraphic letters; instead it has various operators and other symbols (thus the font name 'Symbols') at the position where normally the lowercase letters reside. You can find the exact encoding tables in the LATEX Encoding Guide (`texdoc encguide`), section A.4.

This behavior is unrelated to the AMS fonts; the AMS fonts do not contain any medium-weight calligraphic characters.

9 Turing-Completeness of LATEX

LATEX is a Turing-complete programming language. Roughly, that means that the rules followed in sequence on arbitrary data can produce the result of any calculation. [12] That is, as one can do a lot of things with Turing-complete languages, you can do a lot of things with LATEX, and, more generally, 'compute everything that can be computed' (but that does not imply that every implementation for every computation is simple!).

You might find an implementation of a Turing machine in LATEX at [6]. This is rather theoretic, and I prefer showing the results of a Mandelbrot fractal generated by LATEX. To avoid any ink wastes, consider having a look at [9] by your means. I here give the example of [11]. Consider the code

```
\newcount \Re \newcount \Im
\newcount \Zr \newcount \Zi
\newcount \Zrr \newcount \Zii \newcount \Ind

\newcommand{\MandIter}{%
  \divide \Zr by 16 \divide \Zi by 16
  \Zrr=\Zr \multiply \Zrr by \Zrr %
  \divide \Zrr by 256
  \Zii=\Zi \multiply \Zii by \Zii %
  \divide \Zii by 256
  \multiply \Zi by \Zr \divide \Zi by 256
  \multiply \Zi by 2 \advance \Zi by \Im
  \Zr=\Zrr \advance \Zr by -\Zii \advance %
  \Zr by \Re
  \let\next=\MandIter
  \count4=\Zrr \advance \count4 by \Zii
  \ifnum \count4>262144 \let\next=\relax \fi
  \ifnum \Ind=15 \let\next=\relax \else %
  \advance \Ind by 1 \fi
  \next
}
```

```
\newcommand{\MandLoop}{%
  \Re=\count0
  \multiply \Re by 196608 \divide \Re by \count2 %
  \advance \Re by -131072
  \Im=\count1
  \multiply \Im by 150000 \divide \Im by \count3 %
  \advance \Im by -75000
  \Zr=\Re \Zi=\Im \Ind=0
  \MandIter
  \ifcase \Ind
    .\or .\or :\or -\or +\or =\or *\or i\or I%
    \or H\or O\or X\or M\or \#\or @\or .%
  \fi
  \let\next=\MandLoop
  \advance \count0 by 1
  \ifnum \count0>\count2
    \newline
    \count0=0
    \advance \count1 by 1
    \ifnum \count1>\count3
      \let\next=\relax
    \fi
  \fi
  \next
}

\newcommand{\Mandel}[2]{
  \count0=0 \count1=0 \count2=#1 \count3=#2
  \MandLoop
}

% Document
% --------
\documentclass[a4paper]{article}

\setlength{\parindent}{0pt}
\setlength{\oddsidemargin}{0pt}
\setlength{\topmargin}{0pt}

\begin{document}
\ttfamily
\setlength{\baselineskip}{0pt}
{\small
 \Mandel{100}{60}
}
\end{document}
```

This code generates Figure 2.

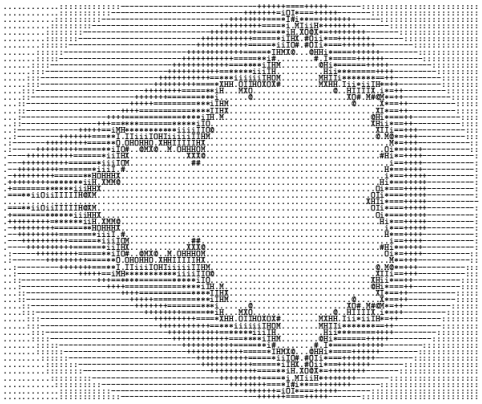

Figure 2: A Mandelbrot fractal generated using LaTeX.

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References

[1] Leo Breebaart. How can you add empty pages to the end of a document?, 2010. http://www.kronto.org/thesis/tips/empty-pages.html.

[2] Richard D. Gill. Richard D. Gill's home page – Product-integrals, 2010. http://www.math.leidenuniv.nl/~gill/.

[3] Peter Flynn. Formatting information: Chapter 7 – Textual tools, 2011. http://latex.silmaril.ie/formattinginformation/chapter7.html#c184.

[4] Marie-Paule Kluth. Comment diviser une cellule par une diagonale?, 1997. http://www.grappa.univ-lille3.fr/FAQ-LaTeX/7.13.html.

[5] Wikimedia Labs. LaTeX/Tips and Tricks – Wikimedia Labs, collection of open-content textbooks, 2010.

[6] LiteratePrograms. Turing machine simulator (LaTeX), 2011. http://en.literateprograms.org/Turing_machine_simulator_(LaTeX).

[7] StackExchange. Why do lower case mathcal letters show up as random symbols?, 2010. http://tex.stackexchange.com/questions/8759/why-do-lower-case-mathcal-letters-show-up-as-ra

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