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CS 3141: Prof. Kamil's Algorithm Analysis
April 8, 2023

LaTeX 2_ε Homework Class Documentation & Testing

Question 1. What is this document?

This is a demonstration of my homework class aiming to ease a few of the *hassles* of LaTeX. It is an extension of the *American Mathematical Society (AMS) Journal Article* (`amsart`) class and should have all of its functionality.

Question 2. What preamble commands does the class have?

We have all that AMS article has, the preamble for this document had:

```
...
\author{Musa Al`Khwarizmi}
\class{CS 3141: Prof. Kamil's Algorithm Analysis}
\date{\today}
\title{Homework Class Test}
\address{Bayt El-Hikmah}
...
```

Question 3. What symbol shortcuts does it have?

It has the symbols shown in table 1,

Macro	Symbol	Macro	Symbol
`\C`	$\mathbb{C}$	`\floor{\frac{x}{2}}`	$\left\lfloor \frac{x}{2} \right\rfloor$
`\R`	$\mathbb{R}$	`\ceil{\frac{x}{2}}`	$\left\lceil \frac{x}{2} \right\rceil$
`\Q`	$\mathbb{Q}$	`\near{\frac{x}{2}}`	$\left\lfloor \frac{x}{2} \right\rceil$
`\Z`	$\mathbb{Z}$	`\arr{\frac{x}{2}}`	$\left\langle \frac{x}{2} \right\rangle$
`\N`	$\mathbb{N}$	`\paren{\frac{x}{2}}`	$\left(\frac{x}{2} \right)$
`\P`	$\mathbb{P}$	`\brk{\frac{x}{2}}`	$\left[\frac{x}{2} \right]$
`\F`	$\mathbb{F}$	`\curl{\frac{x}{2}}`	$\left\{ \frac{x}{2} \right\}$
`\GF, \GF[7]`	$\mathbb{F}_2, \mathbb{F}_7$	`\abs{\frac{x}{2}}`	$\left\lvert \frac{x}{2} \right\rvert$
`\O`	$\varnothing$	`\modulo[7]`	$\mathbb{Z}/7\mathbb{Z}$
`\O(n)`	$\mathcal{O}(n)$	`\vec{v}`	$\vec{v}$
`\?`	$\stackrel{?}{=}$	`\bijective`	$\rightarrowtail\!\!\!\!\rightarrow$
`\is`	$\equiv$	`\surjective`	$\twoheadrightarrow$
`\al`	α	`\injective`	$\hookrightarrow$
`\ep`	ε	`\Ra`	$\Rightarrow$
`\phi`	φ	`\ra`	$\rightarrow$
`\p`	∂	`\derivative[g]{f}`	$\frac{\mathrm{d}f}{\mathrm{d}g}$
`\D`	d	`\derivative{\zeta}`	$\frac{\mathrm{d}\zeta}{\mathrm{d}x}$

TABLE 1. Symbols table.

The commands that have twin delimiters expand according to their input,

$$\lfloor x \rfloor, \lceil y \rceil, \lfloor z \rceil, \langle x, y, z \rangle, \left\lfloor \frac{x}{2} \right\rfloor < \frac{x}{2} < \left\lceil \frac{x}{2} \right\rceil, \left\lfloor \frac{x}{2} \right\rceil, \left\langle \frac{x}{2}, \frac{x}{3}, \frac{x}{4} \right\rangle, \left(\frac{x}{2}, \frac{x}{3}, \frac{x}{4} \right), \left[\frac{x}{2}, \frac{x}{3}, \frac{x}{4} \right], \left\{ \frac{x}{2}, \frac{x}{3}, \frac{x}{4} \right\}, \left\lvert \frac{x}{2} \right\rvert$$

Question 4. Are pictures still a pain though?
No! we have,

```
\img<label>[width]{caption}{path/f0, path/f1, ... , path/fn}
```

Or, you can set the path to all the images once with `\graphicspath{{path}}` in the preamble and then you can do,

```
\img<label>[width]{caption}{f0, f1, ... , fn}.
```

We did `\graphicspath{{../media/}}` with,

```
\img<trio>[0.2]{Al`Khwarizmi}{khwarizmi, kitab, page}
```

to get the figure 1.

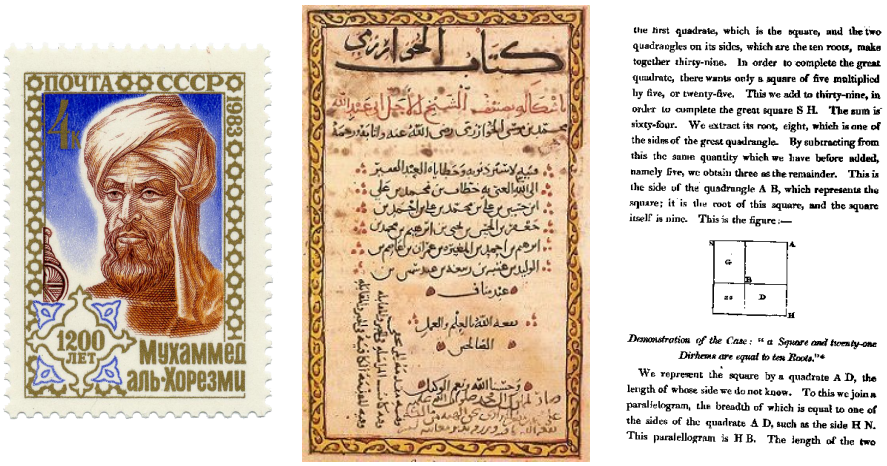

FIGURE 1. Al'Khwarizmi

Question 5. What about tables?
The following code to the left gets you the table 2.

```
\tbl<smptb>{Sample table.} {
  Linear & Polynomial & Exponential \\
  $x$    & $x^2$      & $2^x$       \\
  1      & 1          &     2       \\
  2      & 4          &     4       \\
  3      & 9          &     8       \\
  4      & 16         &    16       \\
  5      & 25         &    32       \\
  6      & 36         &    64       \\
  7      & 49         &   127       \\
}
```

Linear	Polynomial	Exponential
x	x^2	2^x
1	1	2
2	4	4
3	9	8
4	16	16
5	25	32
6	36	64
7	49	127

TABLE 2. Sample table.

Question 6. Do we have all AMS article environments?
Yes! E. g., the proof environment. Note the fancy *Q.E.D* symbol bellow.

```
\begin{proof}
  Four is the sum of two integers.

  $1,3 \in \Z$ and $1+3=4$.
\end{proof}
```

Proof. Four is the sum of two integers.
$1, 3 \in \mathbb{Z}$ and $1 + 3 = 4$.
QUOD ERAT DEM■

Question 7. To show citations and references to custom labels: What is the cardinality of $\mathbb{N}$?
It is $\aleph_0$ [1] (`\cite{arlinghaus1996part}`). See also question IX (`\ref{custom-index}`).

Question 8. What headlines does this class have?
We have the following hierarchy of headlines:

1) `\question[custom-ind]`
2) `\section{name}`
3) `\subsection{name}`
4) `\subsubsection{name}`.

Since we inherited all the section commands from AMS article, we can also use their stared variants. We demonstrate these bellow,

8.1. Section

8.1.1. **Subsection.**

8.1.2. **Subsection.**

8.2. Another Section

8.2.1. **Subsection.**

Subsubsection. This is a started section.

8.2.1.1. *Subsubsection.* We end here.

Question 9. Are all headlines preceded by the question number they are under?
Yes, they are preceded by the index of question they are under.

9.1. Section

9.1.1. **Subsection.**

9.2. Another Section

9.2.1. **Subsection.**

9.2.1.1. *Subsubsection.*

9.2.1.2. *Subsubsection.* We end here.

Question IX. Is the cardinality of Naturals and Reals the same because they are both infinite?
No, the cardinality of $\mathbb{R}$ is greater because they are also uncountable. See also question 7.

Question 10. How much space does a question need at the end of a page?
Starting from the question statement, we need at least 8 lines left on the page or the question moves to next page.
[4]
[5]
[6]
[7]
[8]

Question 11. What is a complete minimal example?

In listing 1 we show a complete document using `homework.cls`,

```
\documentclass{homework}
\author{Musa Al`Khwarizmi}
\class{CS 3141: Prof. Kamil's Algorithm Analysis}
\date{\today}
\title{Minimal Complete Document}
\address{Bayt El-Hikmah}

\begin{document} \maketitle

\question Write down sets in order of containment.

We pretend that equivalence classes are just numbers.
\[
  \C \supset \R \supset \Q \supset \Z \supset \N \supset
  \P \not\supset (\GF[7] = \modulo[7])  \supset \{\nil\}
\]

\question Give an example element of $\O(n)$.

Take $11n \in \O(n)$.

\question Find roots of $x^2- 8x = 9$.

We proceed by factoring,
\begin{align*}
  x^2- 8x - 9         &= 9-9 && \text{Subtract 9 on both sides.}         \\
  x^2- x + 9x - 9     &= 0   && \text{Breaking the middle term.}         \\
  x(x - 1) + 9(x - 1) &= 0   && \text{Pulling out common factors.}       \\
  (x - 1)(x + 9)      &= 0   && \text{Pulling out common } (x - 1).      \\
  x           &\in \{1, -9\} && f(x)g(x) = 0 \Ra f(x) = 0 \vee g(x) = 0.
\end{align*}

\question Show P $\?$ NP.

Let P be zero... Sorry.
\end{document}
```

Listing 1. Complete LaTeX Document

This will get you a document looking like the one in figure 2. Note that it appears bigger for illustration purposes only.

References

[1] Sandra Lach Arlinghaus and SL Arlinghaus. Part ii. elements of spatial planning: Theory. merging maps: Node labeling strategies. *Unknown*, 1996.

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Minimal Complete Document

Question 1. Write down sets in order of containment.
We pretend that equivalence classes are just numbers.

$$\mathbb{C} \supset \mathbb{R} \supset \mathbb{Q} \supset \mathbb{Z} \supset \mathbb{N} \supset \mathbb{P} \not\supset (\mathbb{F}_7 = \mathbb{Z}/7\mathbb{Z}) \supset \{\varnothing\}$$

Question 2. Give an example element of $\mathcal{O}(n)$.
Take $11n \in \mathcal{O}(n)$.

Question 3. Find roots of $x^2 - 8x = 9$.
We proceed by factoring,

$$\begin{aligned}
x^2 - 8x - 9 &= 9 - 9 && \text{Subtract 9 on both sides.} \\
x^2 - x + 9x - 9 &= 0 && \text{Breaking the middle term.} \\
x(x-1) + 9(x-1) &= 0 && \text{Pulling out common factors.} \\
(x-1)(x+9) &= 0 && \text{Pulling out common } (x-1). \\
x &\in \{1, -9\} && f(x)g(x) = 0 \Rightarrow f(x) = 0 \vee g(x) = 0.
\end{aligned}$$

Question 4. Show P $\stackrel{?}{=}$ NP.
Let P be zero... Sorry.

Bayt El-Hikmah

Figure 2. Out document from listing 1.