

IMPROVEMENT OF REFERENCES AND FOOTNOTES IN MATHEMATICAL AND OTHER TEXTS BY CREATING MACROS IN THE LaTeX PROGRAMMING LANGUAGE

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Abstract: The LaTeX programming language considered in this article is used to represent mathematical and other texts in scientific research. Many LaTeX packages provide advanced code-formatting features. Expanding the LaTeX programming language with macros automates the performance of a large number of tasks. In this research, the author programs in the LaTeX system when creating new macros. New macros created by the author improve adding references to everything that can be numbered and improve adding different types of footnotes in texts. Source codes of these new macros are given in this article. These macros can be embodied in a LaTeX style file, and they expand the capabilities of LaTeX.

Key words: macros, source codes, references, footnotes, LaTeX.

1. INTRODUCTION

The LaTeX software and the LaTeX programming language are widely used by scientists. It is important to use LaTeX in the active learning of future scientists [1, 2]. Like source code written in any other programming language, LaTeX is important to include comments within documents.

LaTeX is especially necessary for using math fonts, complex formatting in large and structural documents with references and footnotes, etc. [3–7]. LaTeX can solve any programming task and is able to achieve everything other generic programming languages (e.g., C++, Java, Python) can do [5, 7].

LaTeX includes many packages which provide more advanced code-formatting features.

Definitions for new commands created by means of `\def` and `\newcommand` can be collected together in the preamble of a LaTeX document. If the collection of new

commands is large, it can be placed into a separate file or into a .sty LaTeX package that can be inserted into a LaTeX file.

Analysis of the research and publications shows that there is a need to create new macros that improve writing source code in the LaTeX programming language.

In this article, we consider how to create new macros to improve adding references to everything that can be numbered and to improve adding different types of footnotes in texts in the LaTeX programming language.

2. RELATED WORK AND PROPOSED APPROACH

Study and analysis of work on the application of the LaTeX system shows that there is a need to improve and automate some tasks which can make it possible to present scientific research and its results more clearly and effectively, to create materials for active learning more qualitatively, etc. [3, 7–10]. New macros can be created to expand the capabilities of the LaTeX system and improve the quality and automation of some tasks in LaTeX.

In this article, the author creates new macros in order to improve and automate adding references and to improve and automate adding footnotes in mathematical and other texts of LaTeX documents.

In order to simplify the performance of repetitive tasks that must be performed every time in LaTeX, for example, references to everything that can be numbered (references to figures, references to tables, references to paragraphs, references to equations, etc.), the author improves and automates this process by creating a new macro.

The footnote number and the footnote text to some place in the text of a LaTeX document can be generated at the bottom of the current page. However, in some cases, there is a need to place the footnote number not inside the text but in the margin of a LaTeX document near the required line. For example, this is especially important when a formula occupies an entire line in a text. Then the footnote number inserted in a line can be perceived as part of the formula as an exponent or some index.

For such cases the author creates a new macro that improves and automates adding the footnote number in the margin of a LaTeX document near the corresponding line.

In some cases (for example when reviewing scientific articles, when creating material for active learning, etc.), for clarity and better understanding it is convenient to place footnotes in the margins of articles, books, and other works.

For such cases the author creates a new macro that adds these footnotes qualitatively and automatically.

Since the footnotes in the margins can be placed near the corresponding line, then it may not be necessary to put the footnote number. The macro created by the author makes it possible.

3. PRESENTATION OF THE MAIN RESULTS

Consider how to create new macros in order to improve by adding references to everything that can be numbered in LaTeX documents in mathematical research.

Creating the macro to add a reference to a table, we create a new command `\rs` in the preamble of a LaTeX document:

```
\newcommand\rs[1]{table~\ref{#1}}
```

The following source code where we call this command in the body of the document generates the reference to the table 1 presented in Figure 1:

```
\begin{table}[h]
  \centering
  \begin{tabular}{|c|c|c|c|}
  \hline
    \(\xi\) & 0 & 1 & 50 \\
    \hline
    \(\rho\) & 0,89 & 0,1 & 0,01 \\
  \end{tabular}
  \caption{Distribution of a Random Variable}
  \label{distr}
\end{table}
Distribution of a random variable is given by \rs{distr}.
```

This source code generates the result presented in Figure 1.

ξ	0	1	50
p	0,89	0,1	0,01

Table 1: Distribution of a Random Variable

Distribution of a random variable is given by table 1.

Figure 1. Result generated by source code

Consider how to create new macros in order to improve adding footnotes in LaTeX documents. Let us create a new command `\nt` in the preamble of the LaTeX document:

```
\newcommand\nt[1]{\unskip\footnote{#1}}
```

Then we call this command in the body of the document as in the following example:

```

The probability of lacking collision is equal to
\[\mathcal{Q}_1(v_0, dt_1) = 1 - \frac{u(v_0)}{L} dt_1.\]
If there are  $(N+1)$  particles in the system, then the probability of lacking
collisions of the zero particle with another  $(N)$  particles1 is equal to
Mathematical description of the equilibrium state of symmetric particle
systems. 1Hubal, H.M. Mathematical description of the equilibrium state of symmetric particle
systems. International Journal of Pure and Applied Mathematics,
vol. 119, no. 4, 2018, pp. 717–726. is equal to
\begin{multline*}
\mathcal{Q}_N(v_0, dt_1) =
\left( 1 - \frac{u(v_0)}{L} dt_1 \right)^N \approx
1 - N \frac{u(v_0)}{L} dt_1 = 1 - nu(v_0) dt_1
\text{ as } dt_1 \rightarrow 0.
\end{multline*}

```

and this generates the numbered footnote at the bottom of the page, that is the result presented in Figure 2.

The probability of lacking collision is equal to

$$\mathcal{Q}_1(v_0, dt_1) = 1 - \frac{u(v_0)}{L} dt_1.$$

If there are $N+1$ particles in the system, then the probability of lacking collisions of the zero particle with another N particles¹ is equal to

$$\mathcal{Q}_N(v_0, dt_1) = \left(1 - \frac{u(v_0)}{L} dt_1 \right)^N$$

$$\approx 1 - N \frac{u(v_0)}{L} dt_1 = 1 - nu(v_0) dt_1 \text{ as } dt_1 \rightarrow 0.$$

¹Hubal, H.M. Mathematical description of the equilibrium state of symmetric particle systems. *International Journal of Pure and Applied Mathematics*, vol. 119, no. 4, 2018, pp. 717–726.

Figure 2. Result generated by source code

We can place a footnote number in the margin and the footnote text at the bottom of the page of a LaTeX document. For this, we create a new command `\mft` in the preamble of the document:

```
\newcommand\mft[1]{\marginpar{\footnotemark}\footnotetext{#1}}
```

Then we call this command in the body of the document as in the following example:

If $f_0(q_0) = \frac{1}{L}$, then

$$f(t, q) = \frac{1}{\sigma t \sqrt{2\pi}} \lim_{L \rightarrow \infty} \frac{N}{L} \int_{-L/2}^{L/2} e^{-\frac{(q - q_0)^2}{2\sigma^2 t^2}} dq_0 = \frac{N}{L} = n,$$

i.e. $f(t, q)$ has the sense of concentration. ¹Hubal, H.M. Mathematical description of the non-equilibrium state of symmetric particle systems. *International Journal of Applied Mathematics*, vol. 32, no. 5, 2019, pp. 767–774.

In general, if $f_0(q_0) \rightarrow \text{const}$, then $f(t, q) \rightarrow \text{const}$, i.e. $f(t, q)$ is the uniform distribution which is equilibrium one. An estimation of relaxation time has the form $t \approx L \sqrt{\frac{m}{kT}}$.

that generates the footnote number in the margin and the footnote text at the bottom of the page of the LaTeX document, that is the result presented in Figure 3.

If $f_0(q_0) = \frac{1}{L}$, then

$$f(t, q) = \frac{1}{\sigma t \sqrt{2\pi}} \lim_{L \rightarrow \infty} \frac{N}{L} \int_{-L/2}^{L/2} e^{-\frac{(q - q_0)^2}{2\sigma^2 t^2}} dq_0 = \frac{N}{L} = n,$$

i.e. $f(t, q)$ has the sense of concentration. ¹

In general, if $f_0(q_0) \rightarrow \text{const}$, then $f(t, q) \rightarrow \text{const}$, i.e. $f(t, q)$ is the uniform distribution which is equilibrium one. An estimation of relaxation time has the form $t \approx L \sqrt{\frac{m}{kT}}$.

¹Hubal, H.M. Mathematical description of the non-equilibrium state of symmetric particle systems. *International Journal of Applied Mathematics*, vol. 32, no. 5, 2019, pp. 767–774.

Figure 3. Result generated by source code

In some cases, for example when reviewing scientific articles, it is convenient to place footnotes in the margin of a LaTeX document. For this, we create a new command `\ntm` in the preamble of the document:

```
\newcommand\ntm[1]{%
\unskip~\marginpar{\hspace{0pt}\raggedright\small\itshape#1}%
[$\rightarrow$]}
```

Then we call this command in the body of the document as in the following example:

The solution of the Cauchy problem for the BBGKY hierarchy of equations is the expansion over particle groups whose evolution is governed by the cumulants (semi-invariants) of the evolution operator of the corresponding particle group and has the following form

`\ntm{Hubal,~H.M. Mathematical modeling of non-equilibrium state of non-symmetric particle systems. V~International Scientific and Practical Conference "Prospects of Modern Science and Education", Stockholm, Sweden, \ February 2023, pp.~509–512.}`

$$F_s(t, Y) = S_s(-t, Y) \chi_s(Q^s) \prod \lim_{i=-s_2}^{s_1} F_1(0, x_i) \sum \lim_{n=1}^{\infty} \sum \lim_{n_1+n_2=n} \frac{1}{v^n} \sum \lim_{v_{-(s_2+n_2)}, \dots, v_{-(s_2+1)}, v_{s_1+1}, \dots, v_{s_1+n_1}} \in V^n$$

$$\int \lim_{\mathbb{R}^n} d(Q^{s+n} \setminus \text{minus } Q^s) U(t) \chi_{s+n}(Q^{s+n}) \prod \lim_{i=-} (n_2+s_2)^{n_1+s_1} F_1(0, x_i)$$

where $\chi_{s+n}(Q^{s+n})$ is the characteristic function of the set

$$\mathbb{R}^{s+n} \setminus \text{minus } \{W_{s+n} \cup \text{partial } W_{s+n}^{\varepsilon}\}$$

that generates the footnote text in the margin, that is the result generated in Figure 4.

The created commands can be collected in a separate file with an extension `.tex`. Then the created file with the extension `.tex` can be inserted into a LaTeX file, i.e., it can be inserted into the preamble of the document after loading all packages. Another way to collect the created commands is to create a `.sty` LaTeX package.

The solution of the Cauchy problem for the BBGKY hierarchy of equations is the expansion over particle groups whose evolution is governed by the cumulants (semi-invariants) of the evolution operator of the corresponding particle group and has the following form [→]

$$F_s(t, Y) = S_s(-t, Y) \chi_s(Q^s) \prod_{i=-s_2}^{s_1} F_1(0, x_i) + \sum_{n=1}^{\infty} \sum_{n_1+n_2=n} \frac{1}{v^n} \sum_{v_{-(s_2+n_2)}, \dots, v_{-(s_2+1)}, v_{s_1+1}, \dots, v_{s_1+n_1} \in V_{\mathbb{R}^n}} \int d(Q^{s+n} \setminus Q^s) U(t) \times \chi_{s+n}(Q^{s+n}) \prod_{i=-(n_2+s_2)}^{n_1+s_1} F_1(0, x_i),$$

where $\chi_{s+n}(Q^{s+n})$ is the characteristic function of the set $\mathbb{R}^{s+n} \setminus \{W_{s+n} \cup \partial W_{s+n}^\varepsilon\}$.

Hubal, H.M. Mathematical modeling of non-equilibrium state of non-symmetric particle systems. V International Scientific and Practical Conference "Prospects of Modern Science and Education", Stockholm, Sweden, February 2023, pp. 509–512.

Figure 4. Result generated by source code

4. CONCLUSION

In this article, new macros are created by the author in order to improve and automate adding references to everything that can be numbered and to improve and automate adding different types of footnotes in mathematical and other texts of LaTeX documents. This simplifies the creation of references and footnotes and makes it possible to apply them more effectively and more often. These new macros expand the capabilities of LaTeX and can be used to create mathematical and other texts in scientific research.

The references and footnotes make it possible to more clearly represent scientific research and its results which contributes to the possibility of increasing the quality and effectiveness of scientific research and improves understanding of scientific research.

The use of references and footnotes in educational materials helps to improve active learning and its quality.

Source codes of new macros created by the author are given in this article.

REFERENCES

- [1] Romansky, R. Empirical evaluation of the transfer of information resources in active learning. *International Journal on Information Technologies and Security*, vol. 15, no. 1, 2023, pp. 39-48.
- [2] Atanasov, V., Ivanova, A. A framework for evaluation of web-based learning content. *International Journal on Information Technologies and Security*, vol. 14, no. 4, 2022, pp. 13-22.
- [3] Kottwitz, S. *LaTeX beginner's guide*. Packt Publishing, USA, 2021, (354 p.).
- [4] Hubal, H.M. Mathematical texts and figures in the LaTeX system. *Computer-Integrated Technologies: Education, Science, Production*, no. 32, 2018, pp. 90-94 (in Ukrainian).
- [5] Hubal, H.M. Some capabilities of the LaTeX system when creating specialized texts. *III International Conference "Innovative technologies in science and education. European experience"*, Amsterdam, Netherlands, University UvA, November 2019, pp. 198-201.
- [6] Hubal, H. M. LaTeX multi-line formulas. *XIX International Scientific and Practical Conference "Scientific Bases of Solving of the Modern Tasks"*, Frankfurt am Main, Germany, June 2020, pp. 38–40.
- [7] Ochsner, M., Ochsner, A. *Advanced LaTeX in Academia: applications in research and education*. Springer, 2022, (352 p.).
- [8] Gryshchenko, T.V., Deineko, Zh.V., Nikitenko, O.M. Using the LaTeX system during the preparation of scientific publications. *IV International Scientific and Technical Conference "Print, Multimedia & Web"*, Kharkiv, Ukraine, May 2019, pp. 96–98 (in Ukrainian).
- [9] Lode, C. *Better books with LaTeX the agile way*. Clements Lode Verlag E.K., 2019, (268 p.).
- [10] Gocheva, M., Kasakliev, N., Somova, E. A mobile game-based learning system for primary school mathematics. *International Journal on Information Technologies and Security*, vol. 14, no. 4, 2022, pp. 89-100.

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