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Master Thesis

Your thesis title

Fachgebiet Elektrische Anlagen und Netze

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Acknowledgments

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Abstract

This thesis template is based on the one from GitHub repository of Systems Security Research Group University Duisburg-Essen

Keywords— LaTeX

1 Introduction to LaTeX

LaTeX is a high-quality typesetting system; it includes features designed for the production of technical and scientific documentation. LaTeX is the de facto standard for the communication and publication of scientific documents [1].

At the very beginning of this template and short tutorial of using LaTeX, some basic commands are shown in the following section.

1.1 Basic commands and symbols

In LaTeX, the quotation marks are not recognized as in Microsoft Word or some other text-editing environment. If you type twice ", the output will be ”some quotation”. Hence, one should use `` combined with '' in LaTeX environment instead and the output will be “some quotation”. You can also check this in the source code.

In LaTeX, the “space” used in your code after a common command will not be shown as a space in the generated pdf-file. To add such a space, one should try to insert a ~ symbol to generate an extra space character in the text. For example, LaTeX is a typesetting system , instead of LaTeXis a typesetting system.

There are some characters defined as special characters in LaTeX, e.g. %. To type such characters in the text, try to add a backslash before them (\% instead of %).

Sometimes it is necessary to add some number with units in the text, however the numbers and their units should not be divided into two different lines, hence try to use {\,} instead of “space” character in this case.

For example, you may write:

In 2017, the electricity generated by PV was roughly 38.4 TWh, while wind about 104 TWh [2].

However, it maybe better to write the sentence as:

In 2017, the electricity generated by PV was roughly 38.4 TWh, while wind about 104 TWh.

2 Using Mathematical Expressions

LaTeX offers powerful support for mathematical expressions, which are rather important in scientific documents. In this chapter, several examples to insert mathematical expressions are shown.

2.1 Equations and Formulas

Following are some equations from IEEE Standard 738-2012 [3], which are used here as example and to show some basic operation and LaTeX code to insert mathematical equations into your text.

If you want to insert a single equation (as the one shown in Formula 2.1), just create an "equation" environment and type the corresponding equation.

$$q_r = 17.8 \cdot D_0 \cdot \varepsilon \cdot \left[\left(\frac{T_{max}+273}{100} \right)^4 - \left(\frac{T_a+273}{100} \right)^4 \right] \qquad W/m \tag{2.1}$$

Maybe you also want to explain meanings of the variables used in the equation, LaTeX offers a "tabbing" environment which can be used to align the variables and corresponding explanations. As an example, for the variables used in Formula 2.1, one may write:

where D_0 is the conductor diameter,
ε is the emissivity of surface area,
T_{max} is the maximum operating temperature of the conductor,
T_a is the ambient temperature.

As shown above, to refer one variable or insert some mathematical expression in the text body, one may use `{$ $}` to create a mathematical expression environment.

It is also useful to write some equations in one block (as shown in Formula 2.3), however to make the equations look better, you may align the equations with each other. For example in the exemplary equations, they are aligned to the equal symbol. To align text in LaTeX environment, the `&` symbol is used.

$$q_c + q_r = q_s + I^2 \cdot R\left(T_s\right) \tag{2.2}$$

$$I = \sqrt{\frac{q_c + q_r - q_s}{R\left(T_{max}\right)}} \tag{2.3}$$

Similar to the `\aligh` environment, you may create equations with `\subequations` environment, which will create 2.4a and 2.4b instead of a new number for the second equation as in Formula 2.3 did.

$$q_{c1} = K_{angle} \cdot \left[1.01 + 1.35 \cdot {N_{Re}}^{0.52}\right] \cdot k_f \cdot \left(T_{max} - T_a\right) \qquad W/m \tag{2.4a}$$

$$q_{c2} = K_{angle} \cdot 0.754 \cdot {N_{Re}}^{0.6} \cdot k_f \cdot \left(T_{max} - T_a\right) \qquad W/m \tag{2.4b}$$

2.2 Inline Mathematical Expressions

It is usually necessary to use some mathematical expressions inline, e.g. to mention variables or add units after numbers. As mentioned before, using `{$ $}` inline environment is rather simple, e.g. H_2O (created with `{$ H_2O $}`). However, expressions generated with mathematical environment in LaTeX are always italic. If you wish to have normal expressions, you may use the `\ensuremath` environment, e.g. H_2O (created with `H{\ensuremath{_2}}O`). If you need to insert some mathematical expression quite often, you can also define a new command for such symbols or expressions. For example, you may define a new command for Greek letter omega with

```
\newcommand{\intextOmega}{\ensuremath{^\Omega}}
```

Using 100 mΩ may look a little bit better than 100 m

$m \cdot s^{-1}$ m$\cdot$s^{-1}m$\cdot$s^{-1}

3 Text Structure

In a chapter it usually has several levels of sections and subsections to keep the contents well organized.

3.1 This is a new section

3.1.1 This is a new subsection

Although in LaTeX, there is also a `\subsubsection` command which can generate an extra level of contents under subsection, it is not recommended to be used. The possible solution maybe:

A new paragraph

instead of

3.1.1.1 A subsubsection

It should be noticed that all font types and spacing before or after the titles can be customized in the .cls file.

3.1.2 Make a list

It is also quite often to list out some important points in the text.

- This is an unimportant entry
- This is another unimportant entry :D

4 Figure and Table

In a scientific document, it is necessary and essential to insert several figures or table to visualize the results.

4.1 Insert Images

LaTeX provides several options to handle images and make them look exactly what you need. In this section, some basic operations are explained, e.g. how to include images, how to shrink or enlarge them and how to reference them within your document.

The following code block shows a basic example to insert a figure into the text (see Figure 4.1). The explanations for each line of code are also written in the code block.

```
\begin{figure}[h!]
        % position the figure at the horizontal center
        \centering
        % figure width set to 0.75 times the width of text body
        \includegraphics[width=0.75\textwidth]{fig_1.pdf}
        % set figure caption
        \caption{An exemplary figure}
        % set label for this figure so it can be refered in the text
        \label{fig_1}
\end{figure}
```

Sometimes one need to insert multiple subplots at once. In LaTeX this can be realized by applying the `\subfloat` environment. In Figure **??**, an example is shown, where four subfigures are included in one figure.

In this template, all exemplary figures are generated by matplotlib.pyplot library and scaled to wished size in the text. It should be however noticed, that due to the resizing process in LaTeX, the font size set in original figures may be lost. Therefore, it is important to attempt different font size in your figures generated by software or programming

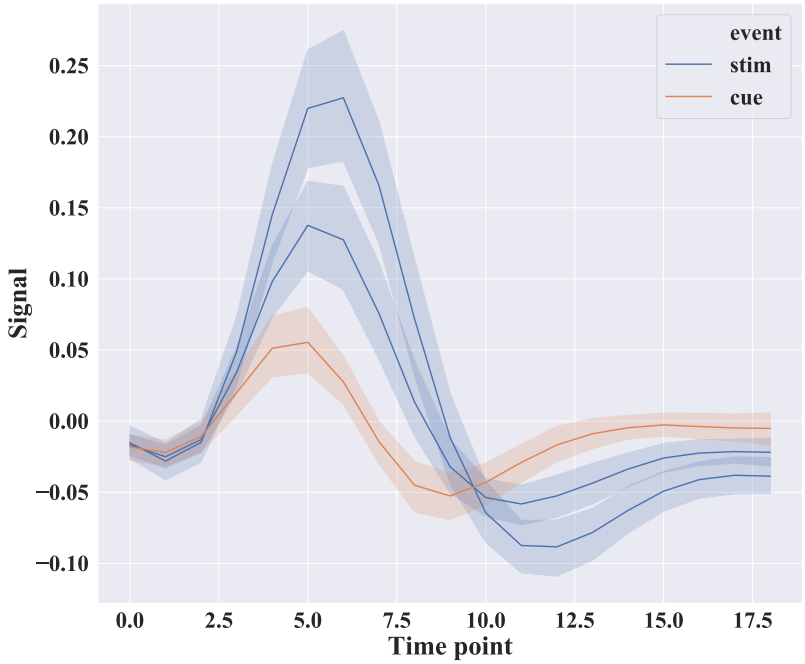
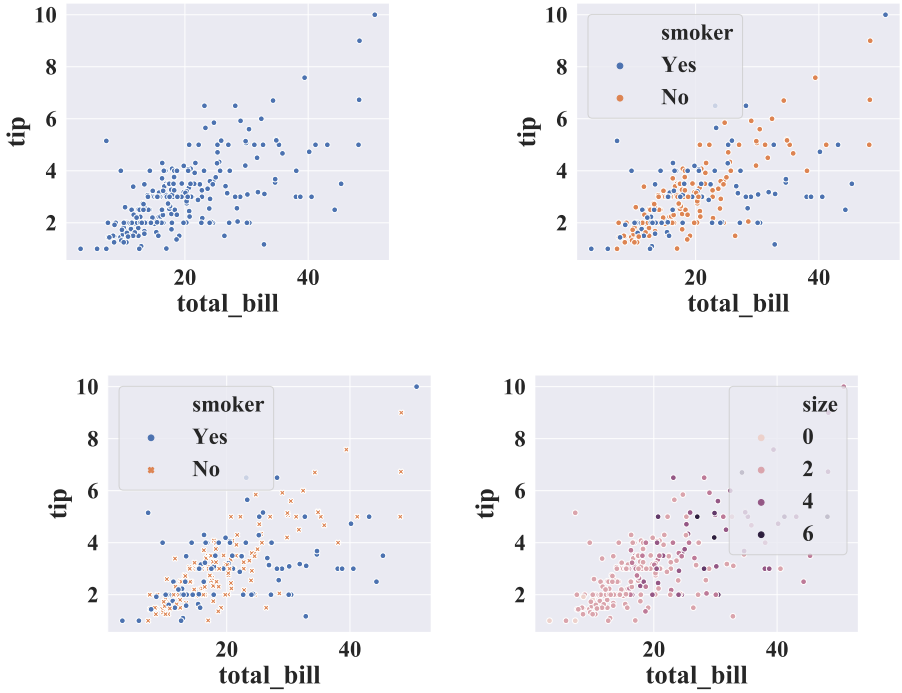


Figure 4.1: An exemplary figure



languages. Another option is to utilize the tikzpicture package in LaTeX, which can help to add text description of axes. An example of using tikzpicture package to obtain the same figure as Figure 4.1 is shown in Figure 4.2. You can compare this two figures and refer to the corresponding codes when necessary.

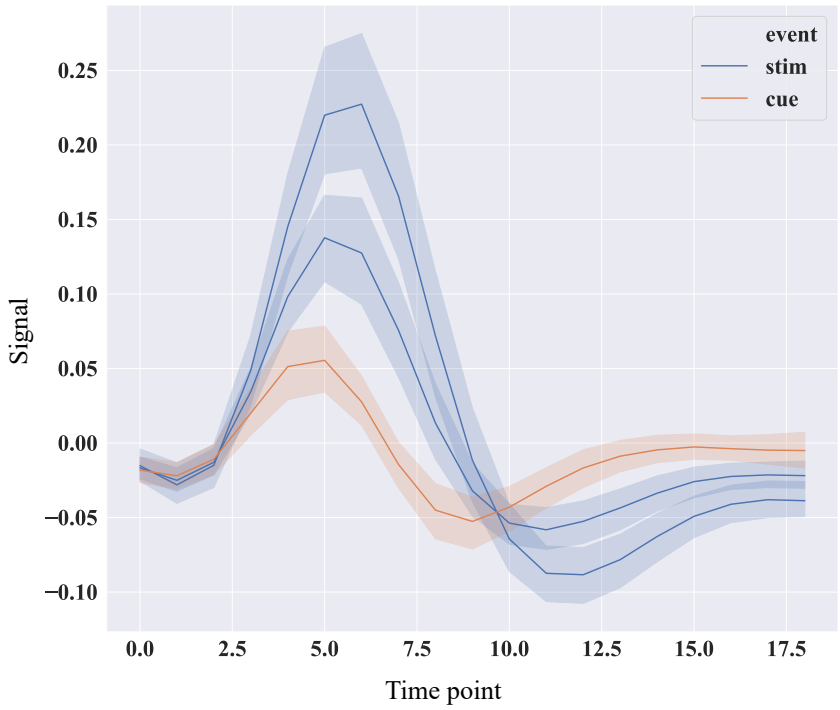


Figure 4.2: An example of tikzpicture

4.2 Inserting Tables

Table is another common element in scientific documents. LaTeXprovides a large set of tools to customize tables. Some most common types and corresponding commands are shown in this section.

Following code block shows a simple example to create a table. The parameter of command `tabular` is aimed to set the number of columns, their delimiters and the alignment types. As shown in the exemplary codes, `| l | c | r |` creates a table with three columns and the "|" symbols create vertical delimiters in the table. The letters are the definitions of alignment for each column, e.g. "l" means left alignment, "c" center and "r" right. To add horizontal delimiters, just add `\hline` before or after the entry of a row.

```
1 \begin{table}
2 \centering
3         \begin{tabular}{| l | c | r |}
4                 \hline
```

```
5                   Points per game & Rebounds per game & Assists per game \\
                        \hline
6                   7.6  & 1.9 & 1.3 \\ \hline
7                   15.4 &  3.1     & 2.5 \\ \hline
8                   19.9 &  5.3 & 3.8 \\ \hline
9           \end{tabular}
10  \end{table}
```

Points per game	Rebounds per game	Assists per game
7.6	1.9	1.3
15.4	3.1	2.5
19.9	5.3	3.8

Table 4.1: An exemplary table

Now the parameter `| l c r |` is used to format columns and some `\hline` commands are removed, the output table is shown in Table 4.2.

Points per game	Rebounds per game	Assists per game
7.6	1.9	1.3
15.4	3.1	2.5
19.9	5.3	3.8

Table 4.2: Another exemplary table

It is sometimes necessary to merge several cells into one to make the table contents more evident. In LaTeX this function can be done by using `\multicolumn{text}{pos}{text}` or `\multirow{text}{width}{text}` commands.

Season	MPG	PPG	RPG	APG	SPG	BPG
1996–97	15.5	7.6	1.9	1.3	.7	.3
1997–98	26.0	15.4	3.1	2.5	.9	.5
1998–99	37.9	19.9	5.3	3.8	1.4	1.0
1999–00	38.2	22.5	6.3	4.9	1.6	.9
2000–01	40.9	28.5	5.9	5.0	1.7	.6
2001–02	38.3	25.2	5.5	5.5	1.5	.4
2002–03	41.5	30.0	6.9	5.9	2.2	.8
2003–04	37.6	24.0	5.5	5.1	1.7	.4
2004–05	40.7	27.6	5.9	6.0	1.3	.8
2005–06	41.0	35.4	5.3	4.5	1.8	.4
2006–07	40.8	31.6	5.7	5.4	1.4	.5
2007–08	38.9	28.3	6.3	5.4	1.8	.5
2008–09	36.1	26.8	5.2	4.9	1.5	.5
2009–10	38.8	27.0	5.4	5.0	1.5	.3
2010–11	33.9	25.3	5.1	4.7	1.2	.1
2011–12	38.5	27.9	5.4	4.6	1.2	.3
2012–13	38.6	27.3	5.6	6.0	1.4	.3
2013–14	29.5	13.8	4.3	6.3	1.2	.2
2014–15	34.5	22.3	5.7	5.6	1.3	.2
2015–16	28.2	17.6	3.7	2.8	.9	.2
Career	36.1	25.0	5.2	4.7	1.4	.5

5 Citation and Bibliography

There are a lot of literature management software in the market, e.g. EndNote, Citavi, Mandeley, etc. Taking Citavi as example, one can add literature and reference sources into this software and exported all references into a bib-file, which can be read by LaTeX and directly added into the generated pdf-file.

In this thesis template, the citation management package used is “biblatex”, hence in Citavi you should export the selected references by setting a “BibLaTeX” export filter. It should be noticed, that the time format supported in the package biblatex is the UTC time format, i.e. yyyy-MM-dd. Citavi also recognize different time formats, e.g. German format dd.MM.yyyy. However, problems may occur when one attempted to export such time format into a bib-file. Therefore, it is recommended to use UTC time format in Citavi and then export.

Each reference entry has a unique BibTeX key within your Citavi project, which can be directly used in LaTeX environment with the command `\cite`. For example, type `\cite{Burger.20180508}` , the corresponding reference will be referred in the text [2].

6 Acronyms and Abbreviations

It is rather handy to use acronyms or abbreviations in your thesis with LaTeX. As defined in the file acronyms.tex, the first entry of `\newacronym` command is the key you entered to call the acronym, while the second one is the short-form of this acronym and the third one is long-form.

For example, an entry of acronym is defined as:

```
\newacronym{der}{DER}{Distributed Energy Resouce}
```

To refer the full version of this term for the first time, you may use `\gls{der}` to get Distributed Energy Resource (DER) as output, `\acrfull{der}` give the same result Distributed Energy Resource (DER), while `\acrshort{der}` for the short form DER and `\acrlong{der}` for the long form Distributed Energy Resource.

If is quite useful to refer an acronym with the plural form and it is quite simple to realize in LaTeX— just add "pl" at the end of one command, e.g. `acrfullpl{der}`, and the output will be Distributed Energy Resources (DERs).

Acronyms

DER Distributed Energy Resource. 8

PV Photovoltaic. 1, 2

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