Tips for Writing Lecture Notes or Papers with Latex

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I. General Tips

√ **Use punctuation in sentences with equations.**

Equations, like words, are part of the sentence and therefore we need to use punctuation.

For instance, Shannon showed [1] that the capacity of a memoryless channel is given by

$$C = \max_{P_X} I(X;Y), \tag{1}$$

where the random variables X and Y denote the input and the output of the channel, respectively. Note, that in (1) there is comma which is part of the punctuation in sentence.

√ **Use the right mathematical notation.**

For instance, the pmf of a random variable X with an alphabet $\mathcal{X}$ may be written as P_X (or $P(x)$ for all $x \in \mathcal{X}$), but not as $P(X)$.

√ **Citation and references: use them correctly.**

Latex is a powerful tool for writing math correctly. For instance, it allows you to give names to equations, theorem and figures using the \label command and then refer to them by the given name. When you refer to an equation add (). *For instance, the capacity of a memoryless channel is given in (1).*

Do not use: Equation (1). Instead use, Equation (\ref{e_capacity}).

√ **Learn how to write math from good writers.**

For instance, use the textbook by Cover and Thomas [2] as an excellent example of a good writing.

√ **Use correctly capital letters.**

When you start a sentence, or there is a name involved use capital letters. *For instance, in Equation (1), in Figure 1, in Theorem 1. However, we write, in "the equation above" and not "in the Equation above".*

√ **Emphasis new definitions.**

Use italic style for new definitions. For instance: The *capacity* of a channel is the supremum of all achievable rates.

√ **Use** $\backslash \log$**,** $\backslash Pr$ $\backslash \max$ **and** $\backslash \min$**.**

For instance, do not write

$$H(X) = \sum_x P(x) log P(x)$$

but

$$H(X) = \sum_x P(x) \log P(x).$$

√ **Keep one equality in a line. If you need more than one equality, break it using eqnarray or align.**

Do not have

$$I(X;Y) = H(X) - H(Y|X) = H(X) + H(Y) - H(Y,X), \tag{2}$$

instead use the following pattern, which is taken from [2]:

$$\begin{aligned} I(X;Y) &\overset{(a)}{=} H(X) - H(Y|X) \\ &\overset{(b)}{=} H(X) + H(Y) - H(Y,X), \end{aligned} \tag{3}$$

where

(a) follows from definition of mutual information,

(b) follows from the chain rule of entropy.

√ **Do not use new line in text.**

Avoid starting new line in a text using $\backslash\backslash$. Instead you may start a new paragraph or equation or just continue the existing paragraph.

√ **Use** $\backslash$left(**and** $\backslash$right) **instead of just** ( ) .

For instance, do not write

$$\log(\sum_{i=1}^{n} x_i) \tag{4}$$

but

$$\log \left(\sum_{i=1}^{n} x_i \right). \tag{5}$$

√ **If possible, provide names for lemmas and theorems.**

For instance:

Lemma 1 (Nonegativity of mutual information): For any two random variables, X, Y,

$$I(X;Y) \geq 0, \tag{6}$$

with equality if and only if X and Y are independent.

This is done using brackets after the lemma, namely, \begin{lemma} [Nonegativity of mutual information].

√ **Introducing the theorem.**

Do not state the theorem abruptly, but first introduce it. Prepare the reader to understand the theorem, understand its main idea and its importance. Here is an example:

Example:

We now show that the entropy of a discrete random variable with finite alphabet $\mathcal{X}$ is bounded by logarithm of the alphabet size, i.e., $\log|\mathcal{X}|$. Furthermore, the unique distribution that achieve this bound is the uniform distribution over $\mathcal{X}$.

Theorem 1: For any discrete random variable X with a finite alphabet $\mathcal{X}$,

$$H(X) \leq \log|\mathcal{X}|$$

with equality if and only if X has a uniform distribution over $\mathcal{X}$.

√ **Introducing the proof.**

When you have a complicated or just long proof, write a paragraph before the actual proof, where you explain the main ideas or the main steps of the proof. Do not start the proof abruptly, but first explain the reader what to expect before he/she starts reading the proof itself.

√ **Placing figures and table in the right place in the paper.**

Its important to place the figure immediately after you mention it or even a little before. You may use the option [h!] to force it, namely, if its a figure use \begin{figure}[h!]{. Similarly for tables.

√ **Keep reasonable size of paragraphs.**

The division into paragraphs is very important. A new paragraph should have a new idea or a new subject and vis versa, namely new idea or subject should be in a new paragraph. Its important extremely important to avoid paragraphs of one sentence or of more than half a page.

√ **"A figure is worth a thousand words."** Use figures! Draw nice figures that explain the setting of the problem, the definitions you use in the paper. Figure may be needed also to illustrate the results (like how the capacity region looks like) and in the results section.

√ **Use math notation in text correctly.** For instance, let say you have an index n that appear in the text. Use math notation $ $, appropriately, for instance, $1, 2, ..., n$ and not text 1,2,...,n.

II. Writing Paper

Writing technical paper is as important as the contest itself. In the following, we attempt to give some guidelines on how to write a good technical paper. A good technical paper should be clear and concise. It is helpful to

remember while writing the paper, that the goal is to convey ideas and results to the readers. A paper usually consists of the following components:

- Paper Title
- Abstract
- Keywords/Index Terms
- Introduction
- System Model/Problem Definition/Setting/+Notations,
- Main Results
- Numerical Results
- Conclusion
- Appendices
- Acknowledgment
- References

Although all technical papers share a common organizational setup you will find some variations within different papers. Common structure of a paper is good due to two simple reasons; it ensures ease of reading, and it helps the readers to move quickly through papers. In fact, experienced readers often do not read entire papers or in chronological order. Therefore, common structure is important, and it is worthwhile to keep it. In the following, we discuss on what should appear in each component.

- **Paper Title**

  The paper title appears on the cover page, centered, and with all nouns capitalized. A good title should be understandable, concise, informative and to the point. Remember that a good title can change a good paper to better one. The author names appear below the title. Example of name that made a huge impact

  Example: ”Writing On Dirty Paper”, by Costa, M.

- **Abstract**

  The abstract should contain a summary of the paper, including:

  - What the paper includes/what we did.
  - Main contribution.
  - New ideas/tools we used.

  Make sure not to cite references in the abstract. Equation may appear if its really crucial.

- **Index Terms**

  They should be selected such that a computerized search will be facilitated. They should be in alphabet order, up to 5-10 terms.

- **Introduction**

  The introduction should contain

  - Historical review: background of the problem, why it is important, and what have been done in previous works to solve the problem relates the problem in our paper. Remember that all existing works should be properly described and references.
  - Motivation for the proposed paper.
  - The proposed solution should be briefly described, with explanations of how it is different from, and superior to, existing solutions.
  - Paper structure with description of what will be described in each section of the paper. Usually it would be the last paragraph of the introduction.

    "The remainder of the paper is organized as follows. Section II defines the ...."

- **Notations/system Model/Problem Definition/Setting**

  This section should contain the notation and the proposed model which is used in the paper/definition or setting of the problem which is concerned in the paper. The notations and format should be consistent throughout the paper.

- **Main results** This is the most important section. Many experienced researchers, will skim the paper and read this section thoroughly. It should consist the main results of the aper where now you can use the notation that has been defined in the previous section. Usually, this section will have theorem, lemmas and algorithms. Sometime, this section is combined with the

- **Various sections deriving the results of the paper** In these sections details of the paper should appear according the to preferable structure that the authors choose. Each section can be a different setting, or different approach, or different tool - most important to have a logical structure.

- **Examples/numerical results**

  Based on the results achieved in the paper, examples and numerical results will be generated. These results should be presented in such a way that the reader will gain intuition about the work. Figures are encouraged. Remember that all the results should be interpreted, if you present a result without an explanation, it is meaningless. Note that this section is a very important and crucial part in the paper. Besides the analytical derivations, numerical results illustrate in different and simple way, the power of the proposed work compared to other works.

- **Conclusion**

  The conclusion should contain

  - Summarization of the main results.

  - Contribution of the paper.
  - Further research/open problems.

- **Appendices**

  In the appendix section, the materials which are inessential to the understanding of the paper, but included for the sake of completeness, should appear. For example, mathematical proofs which are not the very center of the article, are put in the appendix to make the paper more readable.

- **Acknowledgment**

  Usually it includes gratitude to someone who helped in making the article. In conference paper it might also include gratitude to the financial sponsors.

- **References**

  This should contain a list of papers referred to in the paper. If there are both conference version and a journal version of the paper, refer to the journal version.

REFERENCES

[1] C. E. Shannon. A mathematical theory of communication. *Bell Syst. Tech. J.*, 27:379–423 and 623–656, 1948.

[2] T. M. Cover and J. A. Thomas. *Elements of Information Theory*. Wiley, New-York, 2nd edition, 2006.