ECE 5630: Information Theory for Data Transmission, Security and Machine Learning 01/22/20

Instructions for Scribing Lecture Notes

Instructor: Prof. Ziv Goldfeld *Name:* Kia Khezeli, *Net ID*: kk839

This document summarizes a guideline for scribing lecture notes.

Using the LaTeX Template

In order to use and compile the commands introduced in this instruction, you need to include some packages and definitions in the preamble to the document. They are already embedded in the LaTeX template that will be provided to you. Do not modify the `documentclass`, `geometry`, and the macros included in the template. Specifically, your source file should begin as follows.

```
\documentclass[11pt,letterpaper]{article}
\usepackage[inner=0.65in,outer=0.65in,top=0.65in,bottom=0.65in]{geometry}
\usepackage{tkz-linknodes}
\input{macros.tex}
```

Generating the Header

At the beginning of the document, immediately after `\begin{document}`, include the command

`$\lecturenote{title}{date}{name}{Net ID}$`

to generate the header. Other information, e.g., the course title are already embedded in the command. For example, the command used for the header of this document is:

`\lecturenote{Instructions for Scribing Lecture Notes}{01/22/20}{Kia Khezeli}{kk839}`

Notation

Given the theoretical nature of the course, it is important to have consistent notation throughout the semester. In what follows, we summarize common notation to be used in these lecture notes and the commands to generate them.

There are many helpful online resources for common LaTeX symbols and commands. See, for example, the LaTeX symbols Wikipedia page.

- **General Notation**
  - We denote the d-dimensional **Euclidean space** by $\mathbb{R}^d$ using the command `$\mathbb{R}^d$`.
  - **Vectors** are denoted by lowercase boldface letters, e.g., vector $\mathbf{x}$ using the command `$\mathbf{x}$`. The p-norm of vector $\mathbf{x}$ is denoted by $\|\mathbf{x}\|_p$, generated by the command `$\pnorm{p}{\mathbf{x}}$`.
  - We denote **matrices** by uppercase Roman letters, e.g., matrix A using the command `$\mathrm{A}$`. Its **trace** and **rank**, which are denoted by $\mathrm{tr}\,(\mathrm{A})$ and $\mathrm{rank}\,(\mathrm{A})$ are generated by the commands `$\tr{\mathrm{A}}$` and `$\rank{\mathrm{A}}$`, respectively.
  - **Sets** are denoted by uppercase calligraphic letters, e.g., set $\mathcal{X}$ using the command `$\mathcal{X}$`. The **cardinality** of set $\mathcal{X}$ is denoted by $|\mathcal{X}|$ generated by the command `$|\mathcal{X}|$`.

- **Basic Probability**
  - **Random variables** are denoted by uppercase letters, e.g., X using the command `$X$`.
  - **Probability of an event** A is denoted by $\mathbb{P}(A)$ using the command `$\prob{A}$`.
  - The commands for **expectation**, **variance**, and **covariance** are `$\expe{}$`, `$\var{}$`, and `$\cov{}$`, respectively. For example, $\mathbb{E}[X]$ the expected value of random variable X is generated by `$\expe{X}$`.
- **Information Measures**
  - For a discrete random variable X, its **entropy** is denoted by $H(X)$, which is generated by the command `$H(X)$`.
  - For a continuous random variable Y, its **differential entropy** is denoted by $h(X)$, which is generated by the command `$h(X)$`.
  - $I(X;Y)$, the **mutual information** between X and Y is given by `$I(X;Y)$`. It is important not to mix up the semicolon (;) with a comma (,). As will be studied in class, $I(X;Y,Z)$ and $I(X,Y;Z)$ are both valid quantities that represent different things.
  - $D_f(P\|Q)$, the **f-divergence** between P and Q is generated by the command `$\fdiv{P}{Q}$`. Commands to generate common special cases of f-divergence are specified as follows. For Kullback–Leibler (KL) divergence $D_{\mathsf{KL}}(P\|Q)$, use `$\kl{P}{Q}$`. For χ^2-divergence $\chi^2(P\|Q)$, use `$\Chi{P}{Q}$`. For Total Variations (TV) distance $\delta_{\mathsf{TV}}(P,Q)$, use `$\tv{P}{Q}$`. For Squared Hellinger distance $\mathsf{H}^2(P,Q)$, use `$\hel{P}{Q}$`. For Jensen-Shannon divergence $\mathsf{JSD}(P\|Q)$, use `$\jsd{P}{Q}$`.

Writing Instructions

1. Send an email to the course instructor to get the link to the Lecture Notes Overleaf project. There, create a new source file, titled `lecture#.tex`, where `#` should be replaced with the lecture number. Type your lecture notes in that source file.
2. Adhere to the flow, narrative and logical structure presented in class. Presentation of definitions, theorems, proofs, etc. should follows their formulation from class. Intuitive explanations provided in class should be incorporated in the text between the technical parts. In particular, use the 'remark' environment for topic-specific discussions.
3. Include a title in the definition/theorem/remark/etc. environment. The title is inserted by using, e.g., the command:

   ```
   \begin{theorem}[Channel capacity] 'Theorem statement' \end{theorem}
   ```

   This should produces the following text:

   Theorem 1 (Channel capacity) *'Theorem statement'*
4. Use rigorous mathematical language when stating definitions/theorems/lemmas/etc. The rule of thumb is to follow the presentation in class.
5. Use *numbered* sections and subsections to separate topics. Numbering is added automatically by removing the '*' symbol from the `\section*{...}` command.
6. Proof read your document several times before submission to identify flaws, typos, vague phrasing, etc. The submitted lecture notes are expected to be at the optimal level each student is able to produce.

7. Comments for submitted notes will be communicated to students for improving the text. After a couple of iterations the lecture notes should reach the required standard.

8. Use the process of typing lecture notes to further digest the material and solidify your understanding. When typing material we commit to every symbol of every equation. This often uncovers potential gaps in the student's understanding of the material. Use these instances to identify topics you need to further work on. Generally, make this into a learning process worthy of your time and effort.