15-359 A: Probability and Computing — **LaTeX Template**
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Collaborators: none

1 Usage

1.1 Download

Go to https://github.com/jczhang/latex.git to get the latest LaTeX template.

1.2 Installation

This template requires the `minted` package, which uses Python's Pygments to provide syntax highlighting for code. Install `python`, then `pygments` with

```
sudo easy_install pygments
```

When compiling your LaTeX document, make sure to use the `-shell-escape` argument for `pdflatex` so that LaTeX can run Python.

> *Warning.* This enables LaTeX packages to potentially run arbitrary code on your machine. Make sure you know what you're doing.

If you use Sublime Text's LaTeXTools plugin, you can change this by going to **Preferences ▸ Browse Packages...** and editing `LaTeX.sublime-build` under the `LaTeXTools` directory. If you're on Sublime Text 3, this directory might be compressed under `../Installed Packages/LaTeXTools.sublime-package` (this is actually a `.zip` file).

2 Features

2.1 Components

The `\homeworkheader` command can be used to display the header at the top of this page. To use it, edit these commands:

```
\newcommand{\myname}{Jeffrey Zhang}
\newcommand{\myandrewid}{jczhang}
\newcommand{\mydate}{\today}
\newcommand{\mycourse}{15-359 A: Probability and Computing}
\newcommand{\myhwname}{\LaTeX{} Template}
% comment this out if you don't need a note in the homework header:
\newcommand{\mynote}{Collaborators: none}
```

The footer is automatically populated with the corresponding values.

2.2 Environments

Some convenient environments have been included. They are `theorem`, `lemma`, `corollary`, `definition`, `example`, `conjecture`, `exercise`, `problem`, `question`, `task`, `remark`, `warning`, `solution`, `proof`.

2.2.1 Theorem-like

Theorem 2.1 (Pythagorean Theorem). *In a right triangle with legs a, b and hypotenuse c,*

$$a^2 + b^2 = c^2.$$

Lemma 2.2 (Pumping lemma for regular languages).

$$\begin{aligned}&(\forall L \subseteq \Sigma^*)\\ &\quad (\textit{regular}(L) \Rightarrow\\ &\quad ((\exists p \geq 1)((\forall w \in L)((|w| \geq p) \Rightarrow\\ &\qquad ((\exists x, y, z \in \Sigma^*)(w = xyz \land (|y| \geq 1 \land |xy| \leq p \land (\forall i \geq 0)(xy^i z \in L)))))))\end{aligned}$$

Corollary 2.3. *The field of complex numbers is the algebraic closure of the field of real numbers.*

2.2.2 Explanation

Definition 2.4. A Turing machine is a 7-tuple $M = (Q, \Gamma, b, \Sigma, \delta, q_0, F)$ where

- Q is a finite, non-empty set of states
- Γ is a finite, non-empty set of the tape alphabet/symbols
- $b \in \Gamma$ is the blank symbol
- $\Sigma \subseteq \Gamma \setminus \{b\}$ is the set of input symbols
- $q_0 \in Q$ is the initial state
- $F \subseteq Q$ is the set of final or accepting states
- $\delta : Q \setminus F \times \Gamma \to Q \times \Gamma \times \{L, R\}$ is a partial function called the transition function, where L is left shift and R is right shift.

Example 2.5. Is $(n+1)! \in O(n!)$?
No, we have $(n+1)! = (n+1) \cdot n!$, which, for all $n > c$, is larger than $cn!$.

Conjecture 2.6 (Goldbach's conjecture). Every even integer greater than 2 can be expressed as the sum of two primes.

2.2.3 Problem-like

Exercise 2.1 (Positive correlation). Show that if $\Pr[A \mid B] > \Pr[A]$, then $\Pr[B \mid A] > \Pr[B]$.

Problem 2.2 (Relationship). It's complicated.

Question 2.3. Why do you think this is?

Task 2.4. Write test cases for your code.

2.2.4 Information

Remark. I should have used lorem ipsum to construct this section.

Warning. Your hair's on fire!

Solution. Divide the balls into three groups of four balls each. Compare two of the groups; if they are the same weight, the odd ball is in the third group. If they are different weights, give up.

Proof.

$$\begin{aligned}\sum_{i=1}^{k+1} i &= \left(\sum_{i=1}^{k} i\right) + (k+1) \\ &= \frac{k(k+1)}{2} + k + 1 && \text{[by induction hypothesis]} \\ &= \frac{k(k+1) + 2(k+1)}{2} \\ &= \frac{(k+1)(k+2)}{2} \\ &= \frac{(k+1)((k+1)+1)}{2}.\end{aligned}$$

□

2.3 Code

Code highlighting is syntax-dependent. To use a lexer supported by `pygments`, use the `\newlanguage{lang}` command, where `lang` is the name of the lexer. You can then use `\begin{langcode} .. \end{langcode}` to create a code block and `\langshort"..."` to create a one-liner.

```
# returns the first natural number
def hello():
  return 0
```

```
foldl (fn (a, b) => a + b) 0 [1, 2, 3]
```

2.4 Pseudocode

Pseudocode typesetting is available from the `algorithmicx` package.

```
if i ≥ maxval then
    i ← 0
else
    if i + k ≤ maxval then
        i ← i + k
    end if
end if
```

2.5 Math shortcuts

Some math shortcuts have been defined to speed up typesetting.

LaTeX	Result
`\Var(X)`	$\Var(X)$
`\E[X]`	$\E[X]$
`\naturals`	$\naturals$
`\reals^4`	$\reals^4$
`\integers^2`	$\integers^2$
`\powerset(\{0, 1\})`	$\powerset(\{0, 1\})$
`\displaystyle\integral{0}{+\infty}{xe^x}{x}`	$\displaystyle\integral{0}{+\infty}{xe^x}{x}$
`\integral{}{}{x}{x}`	$\integral{}{}{x}{x}$
`\derivative{y}{x}`	$\derivative{y}{x}$
`\derivative{}{x}[f(x)]`	$\derivative{}{x}[f(x)]$

2.6 Other

Links using the `hyperref` package, images using the `graphicx` package, drawings using the `tikz` package.

3 Customization

Besides the homework header text, the colors can be customized easily. Of course, you can hack this template to implement your own desired features. Check out the source code!

4 Bugs/TODO

- Put a little margin above and below code blocks.
- Implement functional pseudocode commands for `algorithmicx`.
- Add background colors to pseudocode.
- Real code and pseudocode line numbers don't line up.
- Some warning messages show up because characters are missing in `inconsolata` or something.
- Currently untested on platforms other than MacTeX.