CS 1678/2078: LaTeX Tutorial

This tutorial intends to make you familiar with writing mathematical formulas in LaTeX.

1 Getting Familiar with Overleaf

If you are unfamiliar with LaTeX, we suggest you use Overleaf, an easy-to-use online LaTeX editor.

1.1 Creating a Project in Overleaf

You can create a new project from the Overleaf main page. Choose **Upload project** and upload the .zip file provided for the final exam. Use the **Recompile** button to compile the .tex file and render the pdf.

2 Writing Mathematical Formulas

Here, we introduce some basics of writing maths in LaTeX that should be enough for writing the final exam. For learning more about LaTeX and Overleaf, we suggest that you have a look at Overleaf guides.

2.1 Adding Packages

To import a package in LaTex, add the following line to the preamble of the document:

```
\usepackage{package_name}
```

where *package_name* is the name of the package you want to add.

For the final exam, all the needed mathematical packages are imported for you.

2.2 Writing Equations

There are two modes for writing maths formulas:

1. **Inline Mode:** Use this mode when writing maths within text. You can use either of the following delimiters to write inline maths formulas:

   ```
   \(...\)
   $...$
   ```

   For Example, this sentence 'The action value of state s and action a is $q_\pi(s, a)$' is written as:

```
The action value of state $s$ and action $a$ is $q_\pi(s, a)$
```

2. **Display Mode** Use this mode when writing maths formulas that are not part of the text. You can use either of the following delimiters for writing maths in display mode:

```
\[...\]
 \begin{equation}...\end{equation}
```

   For Example, the following: The action value of state s and action a is

$$q_\pi(s, a)$$

   is written as:

```
The action value of state $s$ and action $a$ is \[q_\pi(s, a)\]
```

2.3 Common Maths Symbols

Here, we list the codes for some of the maths symbols you might need when writing the exam.

1. **Greek Symbols:** Codes for some of the symbols we commonly use:
   (a) $\gamma \rightarrow$ `\gamma`
   (b) $\pi \rightarrow$ `\pi`
   (c) $\alpha \rightarrow$ `\alpha`
   (d) $\theta \rightarrow$ `\theta`
   (e) $\mu \rightarrow$ `\mu`
   (f) $\nabla \rightarrow$ `\nabla`
   (g) $\infty \rightarrow$ `\infty`
2. **Sub/Superscripts**: To subscript of super script a symbol use `_` and `^`, e.g., x_1^2 is produced by `x_1^2`. Note that super and subscripts only use the next character. If you want to do multiple characters, wrap them in brackets, e.g., S_{t+1} is

```
S_{t+1}
```

3. **Summation:** The code for writing summations is:

```
$\sum_{start}^{end}$
```

Example: $G_t = \sum_{k=t+1}^{T} \gamma^{k-t-1} R_k$ is written as:

```
$G_t = \sum_{k = t+1}^{T} \gamma^{k-t-1} R_k$
```

4. **Expectations:** The code for writing expectations is

   ```
   \mathbb{E}
   ```

   Example: $\mathbb{E}[G_t|S_t = s]$ is written as `$\mathbb{E} [G_t | S_t =s ]$`.

5. **Fractions:** The code for writing fractions, for example $\frac{a}{b}$, is `\frac{}{}`.

6. **Derivatives:** Partial derivatives can be written as

   ```
   \frac{\partial{}}{\partial{}}
   ```

   Example: $\frac{\partial f}{\partial w}$ is written as `$\frac{\partial{f}}{\partial{w}}$`.

   We can also use the ∇ operator to write gradient of the function like $\nabla f(w)$, for which the code is `$\nabla f(w)$`.

7. **Probability Statements:** Probability statements can be written as using Pr with the command `\Pr`. For example $\Pr(A_t = a|S_t = s)$ is `\Pr(A_{t}=a|S_t=s)`.

8. **Scaling brackets**: Using parenthesis () or brackets [] that do not scale with the height of the equation can look weird and be hard to read, e.g.,

   $$l(w) \doteq \mathbb{E}[(Y - \hat{f}(X, w))^2]. \tag{1}$$

   These can be resized automatically, use left/right pairing for each bracket, e.g., `\left (stuff \right )`. This also makes nested brackets look better.

   $$l(w) \doteq \mathbb{E}\left[\left(Y - \hat{f}(X, w)\right)^2\right]. \tag{2}$$

   The code for this equation is

   ```
   l(w) \dot = \mathbb{E}\left [\left (Y-\hat f (X,w)\right )^2 \right ].
   ```

2.4 Aligning Equations

When writing your answers, you might need to align multiple equations or write a long equation over multiple lines. Here, we show some examples of how to align equations.

2.4.1 Splitting Equations

An example of splitting equations over multiple lines:

$$\begin{aligned} G_t &= R_{t+1} + \gamma R_{t+2} + \gamma^2 R_{t+3} + \cdots \\ &= \sum_{k=0}^{\infty} \gamma^k R_{t+k+1} \end{aligned} \tag{3}$$

The code for this example is:

```
\begin{equation}
\begin{split}

    G_t  = &\ R_{t+1} + \gamma R_{t+2} + \gamma^2 R_{t+3} + \cdots\\
         = &\ \sum_{k = 0}^{\infty} \gamma^{k} R_{t+k+1}

\end{split}
\end{equation}
```

The & symbol is used to specified where to align the equations. The '`\ `' is used to specify a space in math mode. So '`&\ `' will align the on a space.

2.4.2 Aligning Multiple Equations

An example of aligning equations is when writing something like:

$$\begin{aligned} q_\pi(s_1, a_1) &= 8 \\ q_\pi(s_1, a_2) &= 5 \\ q_\pi(s_1, a_3) &= -1 \end{aligned}$$

The code for aligning equations, as in this example, is

```
\begin{align*}
    q_\pi(s_1, a_1) = &\ 8 \\
    q_\pi(s_1, a_2) = &\ 5 \\
    q_\pi(s_1, a_3) = &\ -1 \\
\end{align*}
```