User-friendly plain TEX macros for formal logic

Dustin Tucker
dustin.tucker@colostate.edu

Project repository: https://github.com/dusttuck/logic
Source for this document: blah

1 Overview

logic.tex is a collection of mutually-independent plain TEX macros for intuitive typesetting of standard formal logic with code that is easy to produce and easy to parse, even for people with no TEX or programming experience.

I wrote these primarily so that students could complete problem sets, quizzes, and exams on Overleaf, examples of which are available at the GitHub repository.

Here's a list of what the macros cover, with examples on subsequent pages. Click the Overleaf link at the top to view or edit the source for this entire file.

- **Single-character abbreviations for symbols.** For instance,

  `Ax[F(x) > -G(x,a)]` produces $\forall x[F(x) \to \neg G(x,a)]$.

- **Fitch-style proofs**
- **Truth tables**
- **Arguments.** Premises and a conclusion separated by a horizontal line.
- **Diagrams of relative height.** These can be used as countermodels to prove invalidity.
- **\itmath.** Italic math letters with word-like kerning. For instance,

  $\neg Sees(ruth, alonzo)$ instead of $\neg Sees(ruth, alonzo)$.

- **\ssmath.** Sans-serif math letters. For instance, $\mathsf{P} \wedge \mathsf{Q}$ instead of $P \wedge Q$.

(The additional macros used to format this document are included in logicdemofmt.tex, some of which depend on eplain.tex, but the core macros from logic.tex are entirely independent of those as well.)

2 Abbreviations

Three macros make the following characters behave like the listed expressions:

	Character	Expression	
`\connectives`	`-`	`\lnot`	(in math mode)
	`v`	`\mathrel\lor`	
	`^`	`\mathrel\land`	
	`>`	`\rightarrow`	
	`<`	`\leftrightarrow`	
	`!`	`\bot`	
	`=`	`\mathbin=`	
`\quantifiers`	`A`	`\forall`	(in math mode)
	`E`	`\exists`	
`\makeasteriskbig`	`*`	`\big`	(everywhere)

They can be ended with `\endconnectives`, `\endquantifiers`, and `\resetasterisk`. Truth tables (see below) automatically end `\quantifiers`.

To use $\sim$ and & (abbreviated by `~` and `&`) or $\supset$ and $\equiv$ (still abbreviated by `>` and `<`), simply uncomment the relevant lines in the definition of `\connectives`.

3 Fitch-style proofs

`+` produces additional vertical space between lines. I find that it looks better to use two `+`s between consecutive subproofs:

1. $P \lor Q$
2. $P \to R$
3. $Q \to R$ **Goal:** R

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4. P **Assumption** **Setting up:** $\lor$ **Elim** **Goal:** R

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5. R $\to$ **Elim:** 2, 4

6. Q **Assumption** **Setting up:** $\lor$ **Elim** **Goal:** R

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7. R $\to$ **Elim:** 3, 6

8. R $\lor$ **Elim:** 1, 4–5, 6–7

Proofs (and all the other constructions in `logic.tex`) can be used inline, and all the spacing and bar widths are customizable. To customize the indentation of the idiosyncratic notes I use in my class (goal, setting up, etc.), use `\fitchproofindentby`:

Example.

1.	$\exists x \forall y F(x,y)$				
2.	$\forall x \big[\exists y F(y,x) \to G(x)\big]$	**Goal:** $\forall x G(x)$			
3.	$\boxed{a}$ $\forall y F(a,y)$	**Assumption**	**Setting up:** $\exists$ **Elim**	**Goal:** $\forall x G(x)$	
4.	$\boxed{b}$	**Assumption**	**Setting up:** $\forall$ **Intro**	**Goal:** $G(b)$	
5.	$\exists y F(y,b) \to G(b)$	$\forall$ **Elim:** 2			
6.	$F(a,b)$	$\forall$ **Elim:** 3			
7.	$\exists y F(y,b)$	$\exists$ **Intro:** 6			
8.	$G(b)$	$\to$ **Elim:** 5, 7			
9.	$\forall x G(x)$	$\forall$ **Intro:** 4–8			
10.	$\forall x G(x)$	$\exists$ **Elim:** 1, 3–9			

Duplicate `-`s are optional, as are nearly all spaces; only spaces separating `|` from a `-` being used as negation are required (I include leading spaces for readibility, but they can also be omitted):

1.	$A \vee B$				
2.	$A \to C$				
3.	$B \to D$	**Goal:** $\neg D \to C$			
4.	$\neg D$	**Assumption**	**Setting up:** $\to$ **Intro**	**Goal:** C	
5.	A	**Assumption**	**Setting up:** $\vee$ **Elim**	**Goal:** C	
6.	C	$\to$ **Elim:** 2,5			
7.	B	**Assumption**	**Setting up:** $\vee$ **Elim**	**Goal:** C	
8.	D	$\to$ **Elim:** 3,7			
9.	$\bot$	$\bot$ **Intro:** 4,8			
10.	C	$\bot$ **Elim:** 9			
11.	C	$\vee$ **Elim:** 1,5–6,7–10			
12.	$\neg D \to C$	$\to$ **Intro:** 4–11			

A few additional notes:

- If you don't use a colon after the name of a rule in a citation, the line numbers won't typeset quite right.
- A capital `R` that begins a rule name (for **Reit**) will be correctly typeset without math mode.
- The capital `S` is necessary for the **Setting up** note to work properly.

4 Truth tables

- Truth tables automatically call `\endquantifiers`, so there's no need to use that before starting a truth table.
- For correct spacing, every character should be in its own column, separated by periods.
- In every row but the first, asterisks make the following character bold and larger. (If `\makeasteriskbig` is active, it continues to function as `\big` in the first row.)
- In every row but the first, brackets are ignored, so they can be included to make the code easier to read.
- Only the first `+` is required to create the horizontal line; subsequent `+`s are optional.

The following examples illustrate the spacing and capitalization I personally use for formatting truth tables, all of which is optional.

A	B	C	A	$\wedge$	$\neg$	B	C	$\vee$	A	$\neg$	[	C	$\vee$	B	]
T	T	T	t	**F**	F	t	t	**T**	t	**F**	t	T	t		
T	T	F	t	**F**	F	t	f	**T**	t	**F**	f	T	t		
T	F	T	t	**T**	T	f	t	**T**	t	**F**	t	T	f		
T	F	F	t	**T**	T	f	f	**T**	t	**T**	f	F	f		
F	T	T	f	**F**	F	t	t	**T**	f	**F**	t	T	t		
F	T	F	f	**F**	F	t	f	**F**	f	**F**	f	T	t		
F	F	T	f	**F**	T	f	t	**T**	f	**F**	t	T	f		
F	F	F	f	**F**	T	f	f	**F**	f	**T**	f	F	f		

Again, all spacing and bar widths are customizable:

A	B	C	$\neg$	[	A	$\vee$	[	B	$\wedge$	C	]]	$\vee$	[	A	$\vee$	B	]
T	T	T	F		t	T		t	T	t		**T**		t	T	t	
T	T	F	F		t	T		t	F	f		**T**		t	T	t	
T	F	T	F		t	T		f	F	t		**T**		t	T	f	
T	F	F	F		t	T		f	F	f		**T**		t	T	f	
F	T	T	F		f	T		t	T	t		**T**		f	T	t	
F	T	F	T		f	F		t	F	f		**T**		f	T	t	
F	F	T	T		f	F		f	F	t		**T**		f	F	f	
F	F	F	T		f	F		f	F	f		**T**		f	F	f	

5 Arguments

This is the argument the first truth table on the previous page proved invalid:

$$\frac{A \wedge \neg B \quad C \vee A}{\neg[C \vee B]}$$

Changing spacing and the bar width:

$$\frac{\mathit{Taller}(\mathit{ruth}, \mathit{alonzo}) \vee \mathit{Taller}(\mathit{ruth}, \mathit{kurt}) \quad \neg[\mathit{Shorter}(\mathit{kurt}, \mathit{alonzo}) \wedge \mathit{Taller}(\mathit{ruth}, \mathit{kurt})]}{\mathit{Taller}(\mathit{ruth}, \mathit{kurt}) \vee \mathit{Shorter}(\mathit{kurt}, \mathit{alonzo})}$$

6 Diagrams of relative height

- These are a simple way to give countermodels for validity of arguments about relative height.
- Names must be in order from shortest to tallest.
- When using these diagrams inline, they align with the words.

Example:

The previous argument is invalid, as both  and  illustrate.