

User-friendly plain T_EX macros for formal logic

Dustin Tucker
dustin.tucker@colostate.edu

Project repository: <https://github.com/dustttuck/logic>
Source for this document: <https://www.overleaf.com/read/qnnwbwfmfmkz>

1 Overview

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

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,

$$\text{Ax}[F(x) \supset \neg G(x, a)] \quad \text{produces} \quad \forall x[F(x) \rightarrow \neg G(x, a)].$$

- **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.
- **First-order models.**
- `\itmath`. Italic math letters with word-like kerning. For instance,
$$\neg Sees(ruth, alonzo) \quad \text{instead of} \quad \neg Sees(ruth, alonzo).$$
- `\ssmath`. Sans-serif math letters. For instance, $P \wedge Q$ instead of $P \wedge Q$.

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

I wrote these primarily so that students could complete problem sets, quizzes, and exams on Overleaf. Here are a few examples:

- Translations: <https://www.overleaf.com/read/tjmqfmjkqvkx>
- Truth tables: <https://www.overleaf.com/read/yswxpbykzgtj>
- Fitch-style proofs: <https://www.overleaf.com/read/gmbhbqzrbjst>

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	
	<	\leftarrow	
	!	\bot	
	=	\mathbin{=}	
\quantifiers	A	\forall	(in math mode)
	E	\exists	
\makeasteriskbig	*	\big	(everywhere)

They can be ended with \endconnectives, \endquantifiers, and \resetasterisk.

To use \sim and $\&$ (abbreviated by \sim 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.		$P \vee Q$			
2.		$P \rightarrow R$			
3.		$Q \rightarrow R$	Goal: R		
<hr/>					
4.			Assumption	Setting up: \vee Elim	Goal: R
5.			R	\rightarrow Elim: 2, 4	
<hr/>					
6.			Assumption	Setting up: \vee Elim	Goal: R
7.			R	\rightarrow Elim: 3, 6	
<hr/>					
8.		R	\vee 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.	$\forall x [\exists y F(y, x) \rightarrow G(x)]$	Goal:	$\forall x G(x)$	
	3.	$\boxed{a} \quad \forall y F(a, y)$	Assumption	Setting up: \exists Elim	Goal: $\forall x G(x)$
	4.	\boxed{b}	Assumption	Setting up: \forall Intro	Goal: $G(b)$
	5.	$\exists y F(y, b) \rightarrow G(b)$	\forall Elim: 2		
	6.	$F(a, b)$	\forall Elim: 3		
	7.	$\exists y F(y, b)$	\exists Intro: 6		
	8.	$G(b)$	\rightarrow Elim: 5, 7		
	9.	$\forall x G(x)$	\forall Intro: 4–8		
	10.	$\forall x G(x)$	\exists Elim: 1, 3–9		

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

1.	$A \vee B$			
2.	$A \rightarrow C$			
3.	$B \rightarrow D$	Goal:	$\neg D \rightarrow C$	
4.	$\neg D$	Assumption	Setting up: \rightarrow Intro	Goal: C
5.	A	Assumption	Setting up: \vee Elim	Goal: C
6.	C	\rightarrow Elim: 2,5		
7.	B	Assumption	Setting up: \vee Elim	Goal: C
8.	D	\rightarrow Elim: 3,7		
9.	\perp	\perp Intro: 4,8		
10.	C	\perp Elim: 9		
11.	C	\vee Elim: 1,5–6,7–10		
12.	$\neg D \rightarrow C$	\rightarrow 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 `\makeas-teriskbig` is active, `*` 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:

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

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.

7 First-order models

< and > produce ⟨ and ⟩, and slightly decrease the space after commas between them.

Domain: Ruth, Alonzo, Kurt, Julia

Dog: Alonzo, Julia

Happy: Ruth, Alonzo, Kurt

Saw: ⟨Ruth, Ruth⟩, ⟨Ruth, Alonzo⟩, ⟨Ruth, Kurt⟩,
⟨Alonzo, Alonzo⟩, ⟨Alonzo, Julia⟩,
⟨Kurt, Ruth⟩, ⟨Kurt, Alonzo⟩, ⟨Kurt, Julia⟩,
⟨Julia, Ruth⟩, ⟨Julia, Alonzo⟩, ⟨Julia, Kurt⟩

Spacing is again customizable (but increasing the depth of subsequent rows is a little weird):

Domain: Ruth, Alonzo, Kurt, Julia

Dog: Alonzo, Julia

Happy: Ruth, Alonzo, Kurt

Saw: ⟨Ruth, Ruth⟩, ⟨Ruth, Alonzo⟩, ⟨Ruth, Kurt⟩,
⟨Alonzo, Alonzo⟩, ⟨Alonzo, Julia⟩,
⟨Kurt, Ruth⟩, ⟨Kurt, Alonzo⟩, ⟨Kurt, Julia⟩,
⟨Julia, Ruth⟩, ⟨Julia, Alonzo⟩, ⟨Julia, Kurt⟩