

User-friendly plain T_EX macros for formal logic

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

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.
- `\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/tjmqfmjkqvkh>
- 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 | |
| 4. | | | Assumption | Setting up: | \vee Elim Goal: R |
| 5. | | | R | \rightarrow Elim: | 2, 4 |
| 6. | | | Q | Assumption | Setting up: \vee Elim Goal: R |
| 7. | | | R | \rightarrow Elim: | 3, 6 |
| 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  Alonzo Ruth Kurt and  A R K illustrate.