

An online and open-source textbook and homework system for symbolic logic using semantic tableaux

Dave Gilbert (Department of Philosophy) and Jade Lovelace (UBCV undergraduate). (Former project members: Tristan MacKinlay, Kyle Mas, Kamal Deowra, and Max Becker.)

Project Goals

This project has two primary goals:

1. Create a free, open-source, web-based, interactive logic textbook;
2. Create a FIPPA-compliant, free, web-based homework system that can be utilized in introductory logic courses.

Background and Motivation

PHIL 220 (Symbolic Logic) is the largest core course in the Department of Philosophy at UBCV:

- In an average year, 1000–1500 students enroll in a section of the course;
- In most years, at least half of these students are enrolled in a Distance Education (DE) section.

The course faces perennial challenges:

Cost: The standard text/software package used in the DE sections (and some in-person sections) is sold by the UBC bookstore for \$116.

Learning Support: Almost all TA hours are devoted only to marking (often only midterms and finals) with few remaining hours for student interaction.

Transition to further study: Students struggle with the jump from 220 to more advanced logic courses. Primarily, this is due to the focus higher-level courses place on the metatheory of logical systems.

Preexisting Resources and Technology

forallx, UBC: a free, open-source textbook focused on introductory logic written by Prof. Ichikawa (UBCV). Importantly, the text utilizes semantic tableaux as a proof theory:

- Easy (relatively) to learn;
- Facilitates the introduction of metatheoretical concepts earlier in the curriculum, smoothing the transition from introductory to intermediate courses;
- However, there is a dearth of available software for constructing/evaluating tableaux, despite their pedagogical value.

Carnap: An open framework for in-browser formal reasoning and logic exercises developed by Prof. Leach-Krouse (Kansas State).

Image: Tableau Created Using Rudolf within Carnap

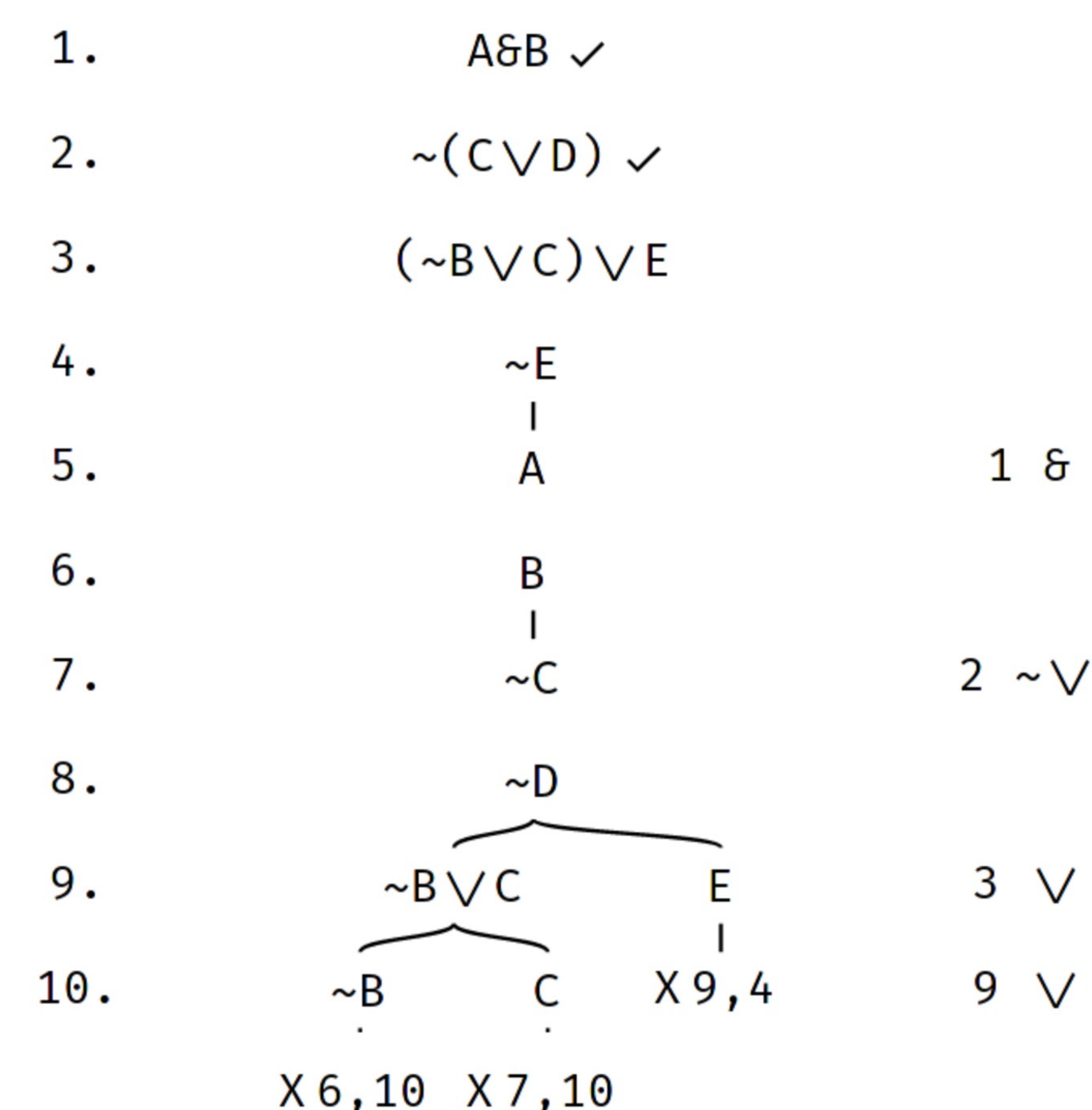
A closed tableau, constructed in-browser with Rudolf, demonstrating

$$\{(A \& B), \sim(C \vee D), ((\sim B \vee C) \vee E)\} \vdash E$$

Image source, demo, and documentation can be found at <https://carnap.io/srv/doc/truth-tree.md>

Technological Outputs to Date

- **Rudolf:** an in-browser, open-source widget for tableau construction/verification in propositional logic. Built into Carnap. (Available at carnap.io.)
- Online version of *forallx, UBC*. Using Carnap and Rudolf, the practice exercises in each chapter are interactive and automatically evaluated, giving instant feedback to students.
- LTI 1.3 integration for Carnap. (Allows Carnap to work in Canvas and other learning management systems.) Students log in to Carnap through Canvas. Carnap accounts are automatically created and user information imported.
- A new, streamlined build system for Carnap. Helped alternate instances of Carnap—including ones hosted in Canada—be more easily set up.
- Problem sets and problem set banks for instructors using *forallx, UBC* as a text.



Classroom Impacts at UBC

- Rudolf and online text used in in-person PHIL 220 sections (W21 T1), allowing students extensive, automatically evaluated practice problems.
- *forallx, UBC* and Carnap (integrated with Canvas) replaced previous text/software package in DE section of PHIL 220 (W21 T2).
- Estimated student savings of \$14,152 in W21 T2 alone.
- In-term TA hours (in W21 T2) devoted entirely to student interaction; LTI integration eliminated account setup/maintenance hours.

Impacts Beyond UBC

- LTI integration already being used at five universities (two more currently in the process of integrating Carnap with their LMS).
- Build system now the standard method of building Carnap.
- Rudolf and *forallx, UBC* (online) freely available.

Current & Future Focus

- Add support to Rudolf for 1st-order tableaux.
- Implement automated grade importing from Carnap to Canvas.

Acknowledgements

We gratefully acknowledge the financial support for this project provided by UBC Vancouver students via the Teaching and Learning Enhancement Fund.

We are also very grateful for the financial support we received from BCCampus (bccampus.ca).

This project would not be at all possible without the support of Graham Leach-Krouse (Kansas State), the creator of Carnap.