Logic Tutorial 2

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Overview

- 16:00 What’s it all good for?
- 16:10 Recap
- 16:20 **Q&A**
- 16:50 Quiz
- 17:00 **Q&A** ->
- 18:00 Feierabend

What's it all good for? – Studies

Bachelor

- Reasoning techniques
- Logic for AI (elective)
- Prolog (elective)

Master

- Foundations of Agents
- Master projects

Logic master Amsterdam, Munich

What's it all good for? – Studies

Programming paradigms

- **Imperative:** C, Java, Python, Javascript
- **Functional:** Elm, Scala, Haskell, Racket
- **Relational:** Prolog

What’s it all good for? – Studies

What's it all good for? – Industry

- Expert systems, decision support systems
  - Law: *Neota Logic, Bryter, LegalOS, KnowledgeTools*
- …

What's it all good for? – Research

Symbolic AI [Explainable AI] *(vs neural AI)*

- Probabilistic logic programming
- Neural logic programming
- Relational machine learning
  - Inductive logic programming
- Neuro-symbolic learning
- Answer set programming
- …

What's it all good for? – Summer schools

~~Law and logic~~

Logic, language and information

~~Logic and formal epistemology~~

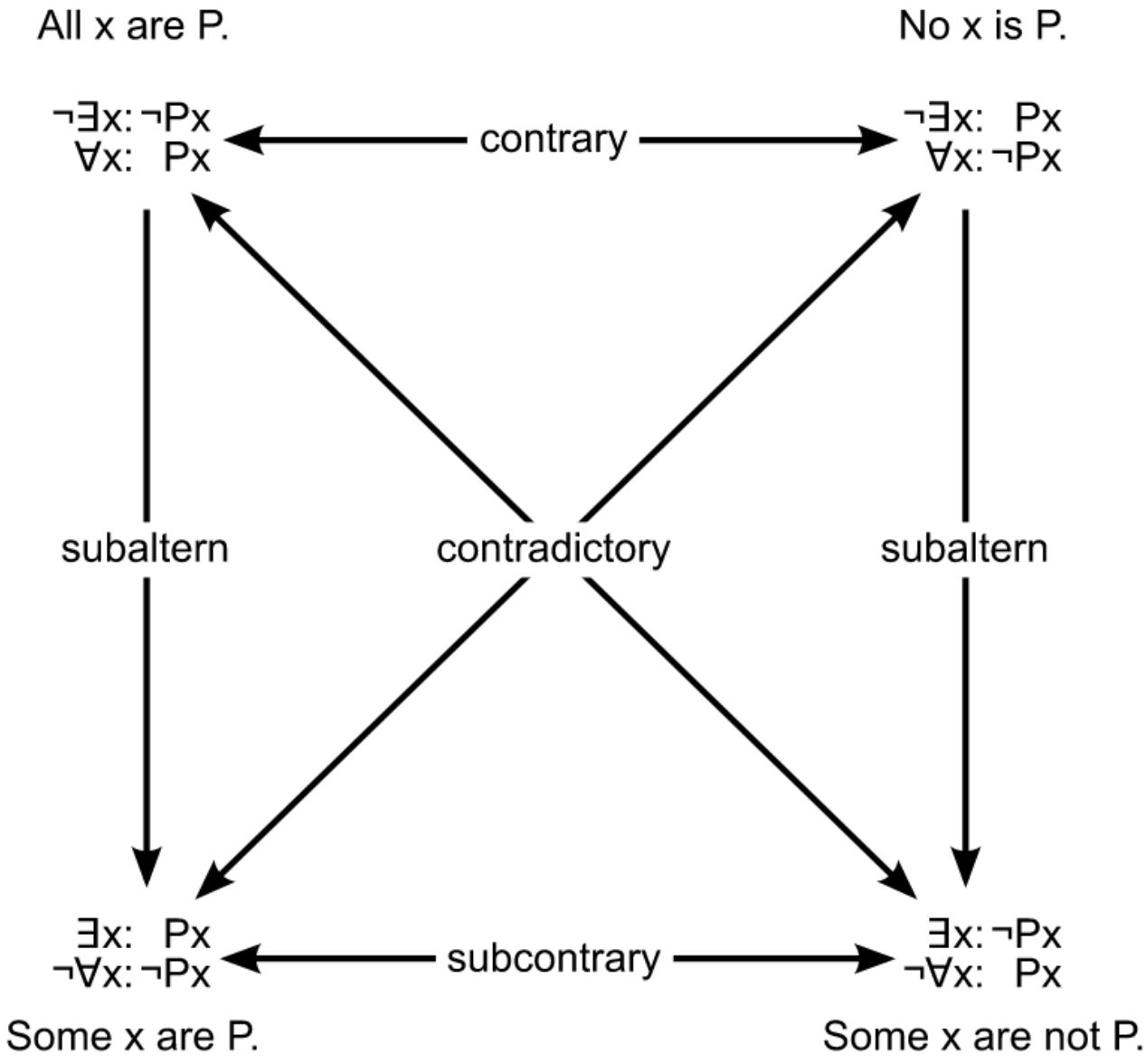
~~Contemporary logic, rationality and information~~

Probability and logic

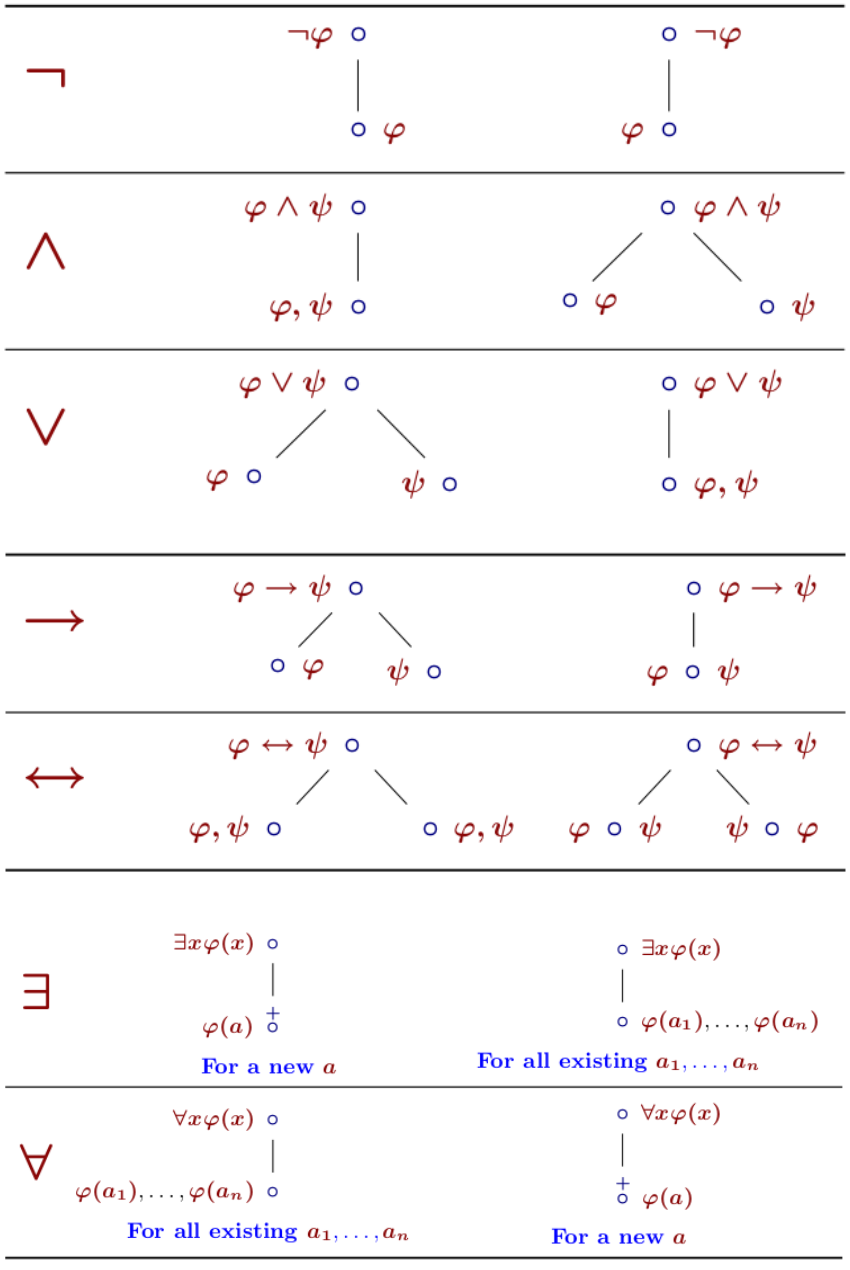
Mathematical philosophy for female students

- More extensive list by UvA

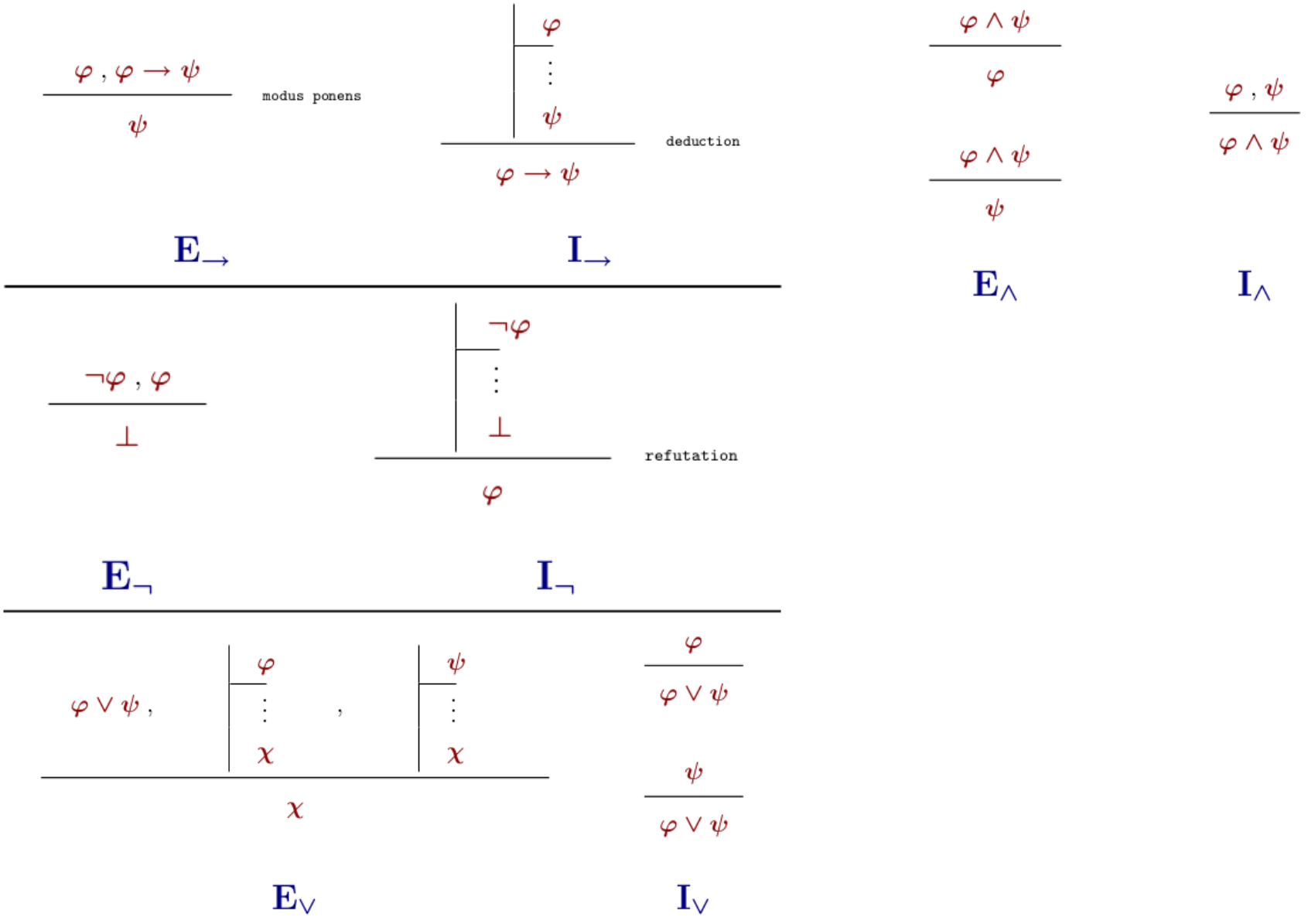
Square of opposition



Semantic Tableau



Natural deduction



Natural deduction

$$\frac{\forall x\,\varphi}{(\varphi)^x_t}$$

provided that no variable in t occurs bounded in φ

$\mathbf{E}_\forall$

$$\dfrac{\begin{array}{l}u\\ \vdots\\ (\varphi)^x_u\end{array}}{\forall x\,\varphi}$$

for u a special symbol not used anywhere else in the proof

$\mathbf{I}_\forall$

$$\dfrac{\exists x\,\varphi\ ,\quad \begin{array}{l}u\\ (\varphi)^x_u\\ \vdots\\ \psi\end{array}}{\psi}$$

for u a special symbol not used anywhere in the proof

$\mathbf{E}_\exists$

$$\frac{(\varphi)^x_t}{\exists x\,\varphi}$$

provided that no variable in t occurs bounded in φ

$\mathbf{I}_\exists$

$$\frac{t_1 = t_2\ ,\ \varphi}{\varphi_{[t_1/t_2]}}\qquad \frac{t_1 = t_2\ ,\ \varphi}{\varphi_{[t_2/t_1]}}$$

where $\varphi_{[t_1/t_2]}$ is the result of replacing, in φ, some ocurrences of t_2 by t_1, provided that

- t_2 contains only variables that occurr freely in φ, and
- t_1 contains only variables that do not get bounded after replacement.

$\mathbf{E}_=$

$$\frac{}{t = t}$$

for any term t.

$\mathbf{I}_=$

Q & A

excalidraw

Q&A - “Moving in” the negation

$\neg \forall x: \neg E y: Rxy$

$E x: \neg \neg E y: Rxy$

$E x: E y: Rxy$

$\neg E x P(x)$

$A x \neg P(x)$

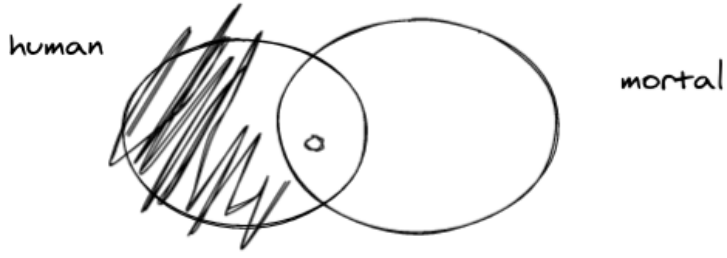
Q&A - Syllogism

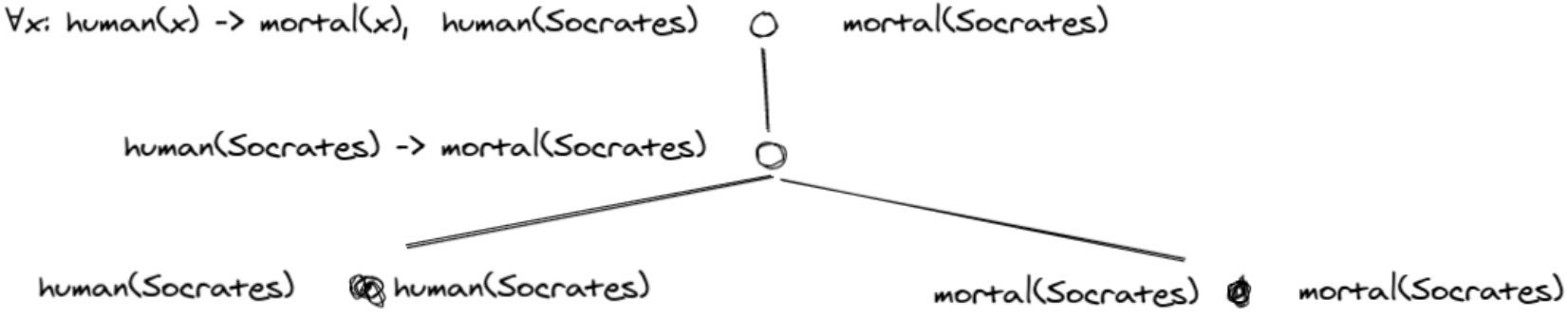
all humans are mortal
socrates is a human
---
socrates is mortal

there is a mortal human

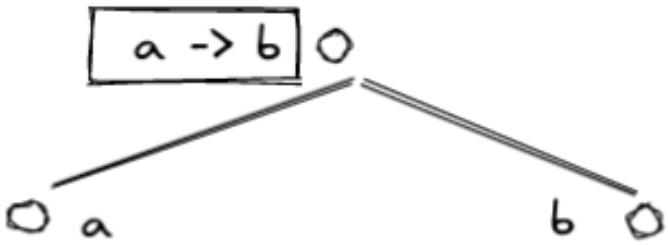
$\exists x$: human(x) $\wedge$ mortal(x)

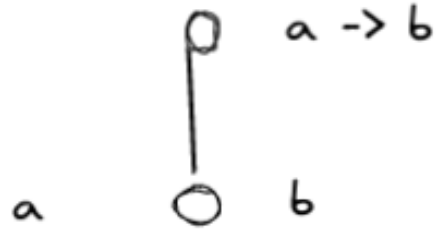
$\forall x$: human(x) -> mortal(x)
human(Socrates)
---
mortal(Socrates)





Q&A - (Counter)examples in a semantic tableau





$\neg a, b$
$\neg a, \neg b$

b, a
$b, \neg a$

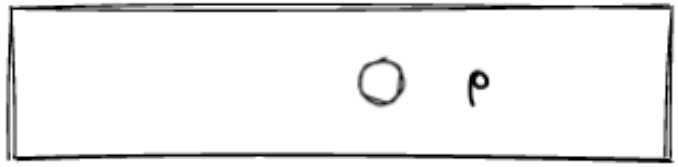
$a \wedge \neg b$

Q&A - Proving validity, invalidity, satisfiability in a semantic tableau

proving that p is valid:

all branches close -> valid

open branch -> counterexample to the validity



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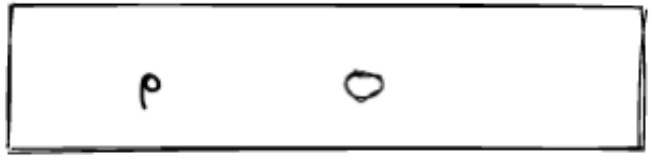
proving that p is invalid:

all branches close -> invalid

open branch -> counterexample to the invalidity
= example for the satisfiability



Q&A - Order of rule application in semantic tableaux

1. eliminate operators $\wedge$ $\vee$ -> $\neg$
2. eliminate existence
3. eliminate all quantifiers

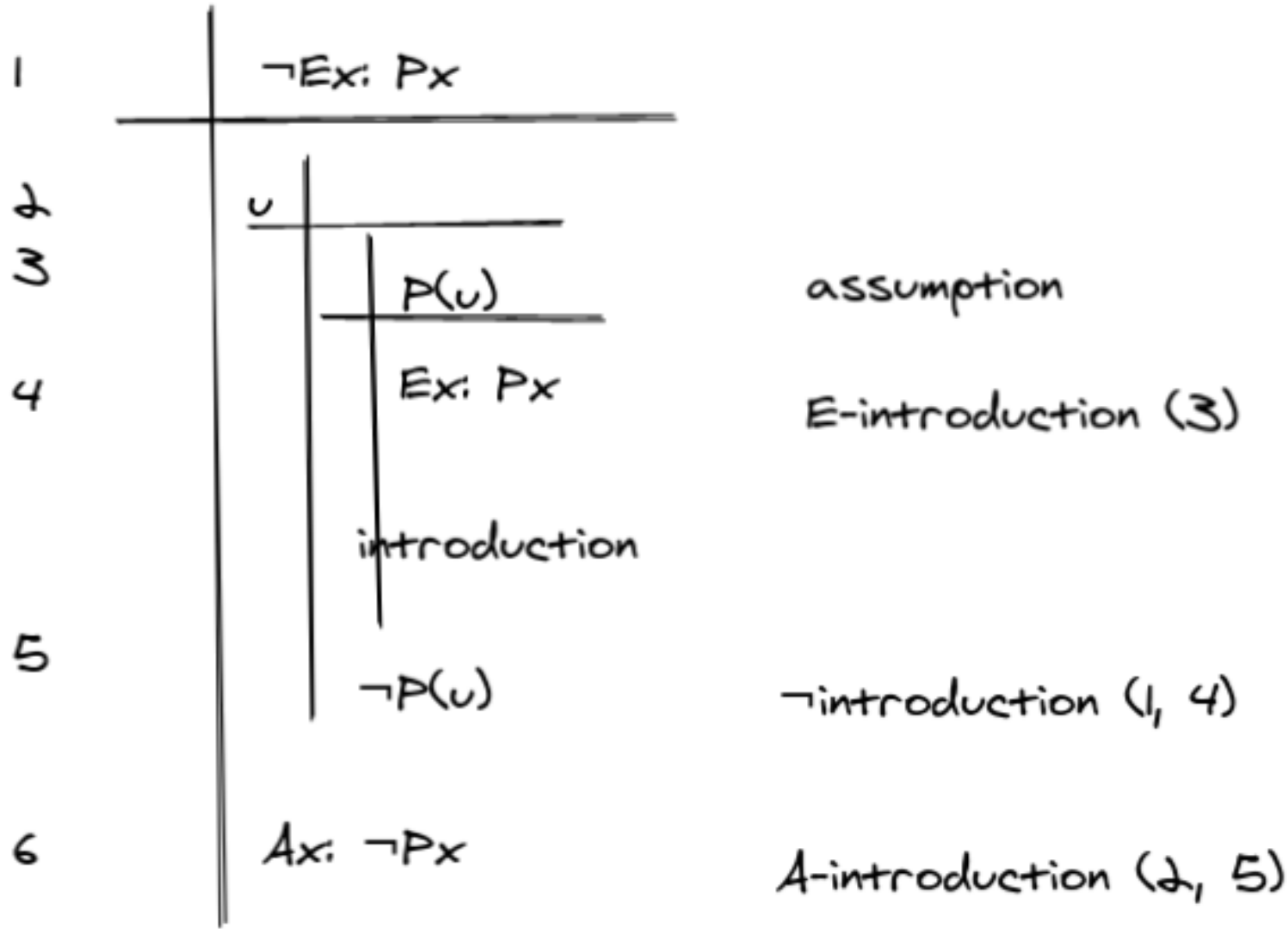
$\forall x: Dx \wedge Ix,$ $\exists x: Ix \vee Cx$ o

$\forall x: Dx \wedge Ix,$ $Ia \vee Ca$ o

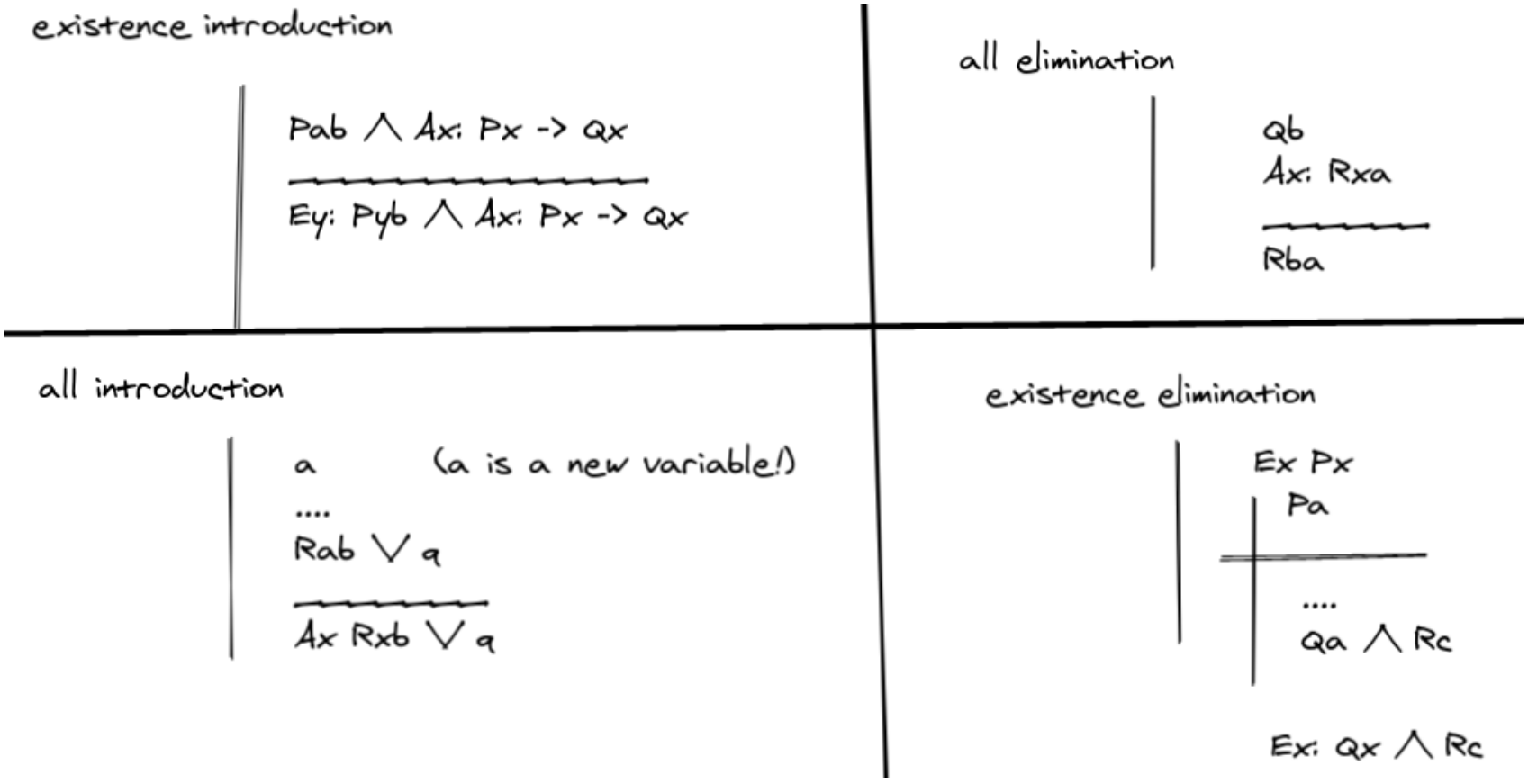
$Da \wedge Ia,$ $Ia \vee Ca$ o

Q&A - Natural deduction

$\neg \exists x\colon Px \models \forall x\colon \neg Px$



Q&A - Examples for the natural deduction rules for predicate logic



Quiz

- Tahook

Feedback

Anonymous feedback form:

- linktr.ee/davidpomerenke