Welcome to PHI 201

Introductory Logic

Outline of Today’s Lecture

- Course Information
- Why Symbolic Logic?
- Propositional Logic Symbolization
- Writing Proofs

Course Information

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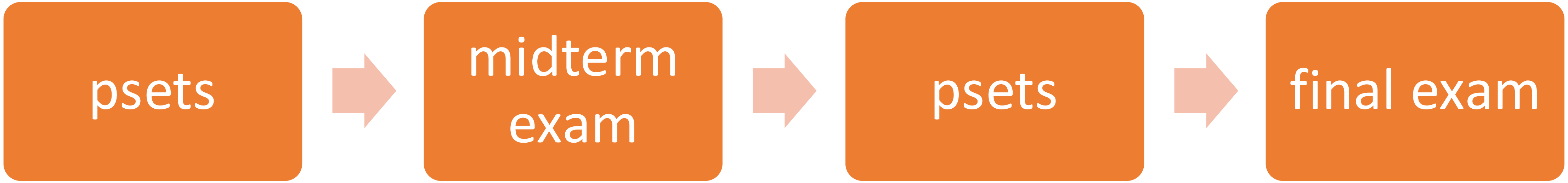
Course flow chart (semester)



Exams – In Class

Midterm

80 minutes
Propositional logic translation, proofs, truth tables

Final

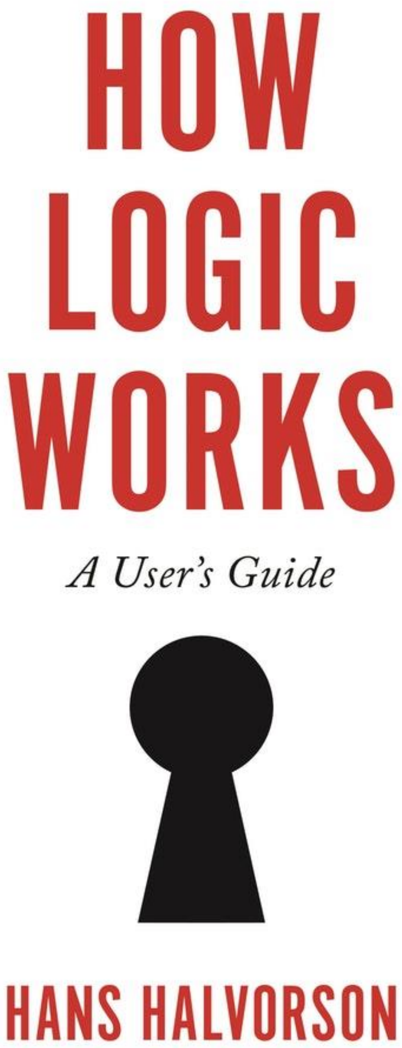
2 hours
Cumulative
Predicate logic translation, proofs, structures

This course is more like a language course than a history course: focus on learning a skill, not on storing information

Course flow chart (weekly)

Problem sets

- Encouraged to work together with other students
  - Don’t copy something if you don’t understand it
- If you rely on AI for psets, then you will flounder on the exams


HOW
LOGIC
WORKS
A User's Guide
HANS HALVORSON

Why Symbolic Logic?

Arguments

- Arguments occur in every academic discipline, and in every profession that requires active thinking
- An argument occurs whenever somebody tries to show that one claim (the **conclusion**) follows logically from some other claims (the **premises**)
- The conclusion and premises are **statements**: declarative sentences that are either true or false.
  - Statement
  - Proposition
  - Assertion

Three goals of this course

- Get better at producing <u>good</u> arguments
- Get better at judging whether arguments are good
- Get better at convincing yourself (and others) that arguments are not good

What is a “good” argument?

- Subjective: ”seems convincing to me”
- Objective: an argument that is strong in an objective sense
  - Abductive argument: premises are intended to give some support for the conclusion
  - Deductive argument: premises are intended to <u>prove</u> (entail, imply) the conclusion
    - A flawless deductive argument is said to be **sound**

What is a sound argument?

To say that an argument is **sound** means:

1. Its premises are true.
2. The truth of its premises establish the truth of its conclusion.

What is an argument’s form?

All people are mortal.
Beyoncé is a person.
Therefore, Beyoncé is mortal.

All Princeton alumni are rich.
Bezos is a Princeton alumnus.
Therefore, Bezos is rich.

All whales are mammals.
Every mammal has a heart.
Every whale has a heart.

All lizards are mammals.
Every mammal has a heart.
Every lizard has a heart.

Some philosophy concentrators are in this class.
Some people in this class are female.
Therefore, some philosophy concentrators are female.

Some philosophy concentrators are in this class.
Some people in this class are physics concentrators.
Therefore, some philosophy concentrators are physics concentrators.

What are the valid argument forms?

- Top down: define valid argument form
- Bottom up: sort arguments into good and bad, then try to figure out what is common to the good ones

Preview

1. Identify propositional form of English sentences
2. Identify some basic valid propositional forms (e.g. modus ponens)
3. Learn how to chain valid forms together

Propositional Logic Symbolization

Thesis

Every sentence has a unique propositional structure: it is built out of logically simple (atomic) sentences, using propositional connectives (such as “...and...” and “...or...”).

Conjunction

Roses are red and violets are blue.

Atomic Sentences

There are infinitely many prime numbers.

1. A sentence is atomic if it contains no connectives – equivalently, contains no proper sub-sentences
2. We will symbolize an atomic sentence with a single letter

Negation

Roses are not blue.

It is not the case that (roses are blue).

It is not the case that B.

Embedded negation

Roses are red and violets are not green.

R and not-G

It is not the case that roses are red and violets are green.

It is not the case that (roses are red and violets are green)

Disjunction

Either roses are red or violets are blue

Either R or B

Either roses are red or both violets are blue and emeralds are green.

Either roses are red or (violets are blue and emeralds are green)

Conditional (if … then …)

If Biden wins PA then Biden wins the election

If P then E

If Biden lost the election then he lost both Pa and Ga

Peculiar constructions

Neither P nor Q

Peculiar constructions

Not both P and Q

Peculiar constructions

P only if Q

A person can vote in the US election only if she is at least 18 years old

Peculiar constructions

P unless Q

Trump will be nominated unless Haley pulls off an upset.

If Jones isn't a crook, then neither is Smith.

I will graduate, provided I pass both logic and history.

I will SUCCEED only if I WORK hard and take RISKS.

JONES will win the championship unless she gets INJURED, in which case SMITH will win.

If you work hard only if you are threatened, then you will not succeed.

If you CONCENTRATE well only if you are ALERT, then provided that you are WISE you will not FLY an airplane unless you are SOBER.

Summary

Propositional connectives

And	$\wedge$
Or	$\vee$
Not	$\neg$
If...Then...	$\rightarrow$

Atomic sentences

Writing Proofs

Goal: be able to reproduce all and only valid argument forms

Examples

1. Should be able to prove $P \vee \neg P$
2. Should not be able to prove $P \wedge \neg P$

Constructing validities

1. Atoms = one step basic arguments
2. Molecules = string arguments together

Philosophical idea

- Each valid inference is licensed by the meaning of some or other special logical word
- For each propositional connective, there will be an introduction rule and an elimination rule

Plan of action

1. Deducing: rule of assumptions, and-elim, and-intro, or-intro, if-elim (modus ponens), modus tollens, double negation intro and elim
2. Supposing: if-intro (conditional proof), or-elim, reductio ad absurdum

See page 231 of HLW for a summary of the inference rules

Rule of assumptions

If we ask you to prove **conclusion** Y from **premises** $X_1,\ldots,X_n$, then you should begin your proof with these assumed lines:

(1) X_1 A

(2) X_2 A

(n) X_n A

The "A" on the right indicates "Assumption", and is the **justification** for the line

and-elimination

and-introduction

$$P \land Q \vdash Q \land P$$

To show: $P \vdash P \land P$ and $P \land P \vdash P$

To show: $(P \wedge Q) \wedge R \vdash P \wedge (Q \wedge R)$

or-introduction

To show: $P \vdash Q \vee (P \vee Q)$

To show: $P \land Q \vdash Q \lor R$

To show: $P \wedge Q \vdash (P \vee R) \wedge (R \vee Q)$

Modus ponens (MP)

$(m)\ A \rightarrow B$
$(n)\ \ A$
$\vdots$
$(o)\ B \qquad\qquad \mathrm{m, n\ MP}$

To show: $(P \vee Q) \rightarrow R, P \vdash R$

To show: $P \to (P \to Q), P \vdash Q$

Modus tollens (MT)

$$
\begin{array}{ll}
(m)\ A \rightarrow B & \\
(n)\ \neg B & \\
\vdots & \\
(o)\ \neg A & \mathrm{m, n\ MT}
\end{array}
$$

To show: $Q \to (P \to R), \neg R \land Q \vdash \neg P$

Double negation (DN)

$(m) A$

$(n) \neg\neg A$ m DN

$(m) \neg\neg A$

$(n) A$ m DN

To show: $P \rightarrow \neg Q, Q \vdash \neg P$

To show: $\neg(P \to Q) \to Q, \neg Q \vdash \neg P$