Philosophy 57 — Day 19

- Quiz #4 Grading Clarification
  - Curve: 80-100 (A); 65-75 (B); 55-60 (C); 40-50 (D); < 40 (F)
  - Part I: 10 Points Each; Part II: 20 Points Each
- New Versions of LogicCoach Available Online (see our Links Page)
  - LogicCoach is *very* useful for chapter 6 problems
  - WebVenn can also be downloaded from our Links Page
- Quiz #5 Next Tuesday (04/15)
  - 3-Circle Venn Diagram Technique
  - No Translation or Symbolization
  - No Reducing the Number of Terms
- Finishing Chapter 5 & Onto Chapter 6
  - Reducing the Number of Terms
  - Introduction to Chapter 6 (Propositional Logic)

Chapter 5: Section 5.4 — Reducing the # of Terms

- Consider the following English syllogism:

  All photographers are non-writers.
  Some editors are writers.
  Therefore, some non-photographers are not non-editors.

- In symbolic form, this can be written as follows:

  All P are non-W.
  Some E are W.
  Therefore, some non-P are not non-E.

- This syllogism is *not* in standard form, since it has **6** terms, but it *can* be fixed.
- We need to *transform* the three statements in such a way that: (1) we do not change their meaning, and (2) we end-up with 3 terms in the syllogism.
- In fact, we can transform this syllogism into standard form in such a way that we use only the three terms P, W, and E. But, how? Recall one of our tables.

Chapter 5: Section 5.4 — Reducing the # of Terms, Cont'd

Proposition	**Converse**	**Obverse**	**Contrapositive**
(**A**) All A are B.	All B are A. ($\neq$)	No A are non-B. (=)	All non-B are non-A. (=)
(**E**) No A are B.	No B are A. (=)	All A are non-B. (=)	No non-B are non-A. ($\neq$)
(**I**) Some A are B.	Some B are A. (=)	Some A are not non-B. (=)	Some non-B are non-A. ($\neq$)
(**O**) Some A are not B.	Some B are not A. ($\neq$)	Some A are non-B. (=)	Some non-B are not non-A. (=)

- And, recall the syllogism we are trying to convert into standard form:

  All P are non-W.
  Some E are W.
  $\therefore$ Some non-P are not non-E.

- We need to transform the syllogism in such a way that: (1) we preserve the meaning of each claim, and (2) the syllogism only contains **3** terms.
- We also need the result to be in **standard form** (may require re-arranging premises). It's OK to have complements ("non-X"s) in the resulting syllogism.
- There may be *multiple* correct transformations! Here, there are at least two.

Chapter 5: Section 5.4 — Reducing the # of Terms, Cont'd

- Here are two correct transformations into standard form:

All P are non-W.		No P are W.
Some E are W.	$\mapsto$	Some E are W.
$\therefore$ Some non-P are not non-E.		$\therefore$ Some E are not P.
	or	
		Some W are not non-E.
	$\mapsto$	All W are non-P.
		$\therefore$ Some non-P are not non-E.

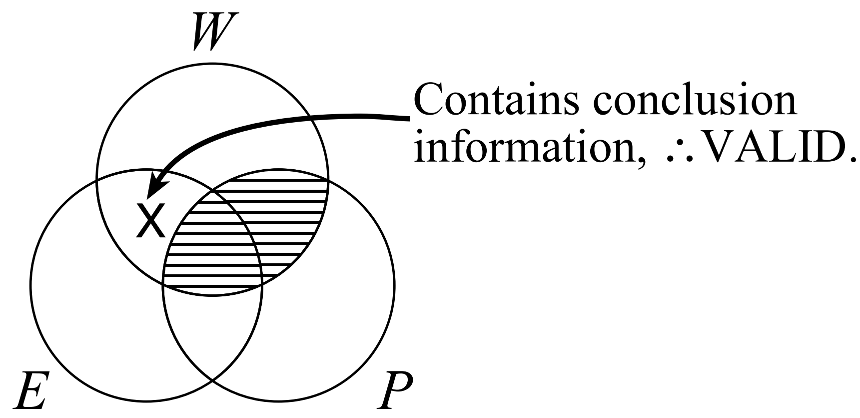
- In the 2nd case, we had to re-arrange the premises in order to get the syllogism into standard form. It's OK that we have "non-P" and "non-E" in the result.
- Let's do Venn Diagrams to check and see if these transformations are valid categorical syllogisms. They had better yield the same result!
- NOTE: No special technique is involved for doing 3-circle Venn Diagrams for syllogisms which contain complements ("non-X"s).

Syllogism in standard form

No P are W.
Some E are W.
$\therefore$ Some E are not P.

Mood–Figure: **EIO**–2

Venn Diagram of Premises

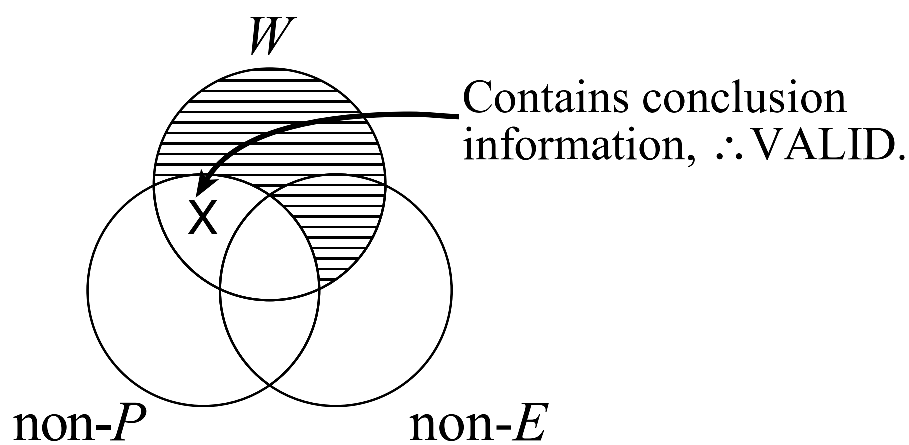


Syllogism in standard form

Some W are not non-E.
All W are non-P.
$\therefore$ Some non-P are not non-E.

Mood–Figure: **OAO**–3

Venn Diagram of Premises



Chapter 6 — Propositional Logic I

- In chapters 4 and 5, we were working in Categorical Logic (CL), which only allows us to express quantified claims about categories or classes of things.
- In chapter 6 (and time permitting, ch. 7), we will be working in Propositional Logic, which is a different, and more expressive logical language.
- In Propositional Logic (PL), the basic units of analysis (represented by capital letters A, B, …) are not classes or categories, but *simple statements*.
- A simple statement does not contain any other statement as a component. A compound statement contains at least one simple statement as a component.

Simple Statements:

- Today is Halloween.
- The monk seal is endangered.
- James Joyce wrote *Ulysses*.
- Parakeets are colorful birds.
- Butane is a hydrogen compound.

Compound Statements:

- Either it's raining or it's snowing.
- If Dell introduces a new line, then Apple will also.
- Snow is white and the sky is blue.
- It is not the case that Emily Bronte wrote *Jane Eyre*.
- John is a bachelor if and only if he is unmarried.

Chapter 6 — Propositional Logic II

- If we use capital letters to denote simple statements, then we can re-write the above statements in a pseudo-symbolic form, as follows:

Simple Statements:	**Compound Statements:**
• *H*.	• Either *R* or *S*.
• *M*.	• If *D*, then *A*.
• *J*.	• *W* and *L*.
• *P*.	• It is not the case that *E*.
• *B*.	• *I* if and only if *U*.

- The expressions "or", "If", "and", "not" , "if and only if" are called connectives or operators, because the operate on or connect simple statements.
- We will use special symbols for these five connectives (or operators). Specifically, we will use the symbol "$\sim$" for "not", "$\vee$" for "or", "$\bullet$" for "and", "$\supset$" for "if", and "$\equiv$" for "if and only if". Here's a table:

Operator	Name	Logical Function	Used to translate
$\sim$	tilde	negation	not, it is not the case that
$\bullet$	dot	conjunction	and, also, moreover, but
$\vee$	wedge	disjunction	or, unless, either ... or ...
$\supset$	horseshoe	implication	if ... then ..., only if
$\equiv$	triple bar	equivalence	if and only if

- Using these symbols, we can cast our compound examples in symbolic form:

Pseudo-Symbolic:	**Full Symbolic:**
• Either R or S.	• $R \vee S$.
• If D, then A.	• $D \supset A$.
• W and L.	• $W \bullet L$.
• It is not the case that E.	• $\sim E$.
• I if and only if U.	• $I \equiv U$.

- Our first topic is *translation* from English into PL.

Chapter 6 — Propositional Logic III

- We have five types of statements (or statement forms) in PL. These are:

Statement Form:	Statement Name:	Statement Components:
$\sim p$	negation	–
$p \bullet q$	conjunction	p, q called conjuncts
$p \vee q$	disjunction	p, q called disjuncts
$p \supset q$	conditional	p called antecedent, q called consequent
$p \equiv q$	biconditional	–

- NOTE: I use lower-case letters p, q, etc. as *variables*, which range over sentences in PL. How are these different than upper-case letters?
- PL sentences can be arbitrarily complex. But, they are always constructed out of upper-case letters, and connectives (or operators). Non-examples?
- The main operator in a (compound) PL sentence is the operator that governs the largest component(s) in the statement. The following are all negations:

$$\text{“}\sim B\text{”} \qquad \text{“}\sim(G \supset H)\text{”} \qquad \text{“}\sim[(A \equiv F) \bullet (C \equiv G)]\text{”}$$

Chapter 6 — Propositional Logic Translations I

- Whenever 3 or more letters are appear, parentheses (or brackets or braces) must be used carefully to indicate the proper range of the connectives.
- For instance, the string of symbols "$A \bullet B \vee C$" is *ambiguous*. It could represent either "$(A \bullet B) \vee C$" or "$A \bullet (B \vee C)$". These have *different meanings*!
- A well-formed formula (WFF, for short) is a grammatical PL sentence. In English, "Porch on the is cat a there" is ungrammatical. And, in PL, the following strings of symbols are not WFFs, because they are ungrammatical:

  "$A \supset \vee B$" "$A \bullet B \vee C$" "$A \supset B \supset C$" "$\sim \vee B(\vee C)$"
- Here are some examples, to illustrate the importance of proper grouping.
  1. Prozac relieves depression and Allegra combats allergies, or Zocor lowers cholesterol. $\mapsto (P \bullet A) \vee Z$
  2. Prozac relieves depression, and Allegra combats allergies or Zocor lowers cholesterol. $\mapsto$??

3. Either Prozac relieves depression and Allegra combats allergies or Zocor lowers cholesterol. $\mapsto$??
4. Prozac relieves depression and either Allegra combats allergies or Zocor lowers cholesterol. $\mapsto$??
5. Prozac relieves depression or both Allegra combats allergies and Zocor lowers cholesterol. $\mapsto$??
6. If Merck changes its logo, then if Pfizer increases sales, then Lilly will reorganize. $\mapsto$??
7. If Merck's changing its logo implies that Pfizer increases sales, then Lilly will reorganize. $\mapsto$??
8. If Schering and Pfizer lower prices or Novartis downsizes, then Warner will expand production. $\mapsto$??

- Do not confuse the following three statement forms:

  "A if B" $\mapsto$ "$B \supset A$" "A only if B" $\mapsto$ "$A \supset B$" "A if and only if B" $\mapsto$ "$A \equiv B$"

Chapter 6 — Propositional Logic Translations II

- The tilde "$\sim$" operates *only* on the unit that immediately follows it. In "$\sim K \vee M$," $\sim$ affects only "K"; in "$\sim(K \vee M)$," $\sim$ affects the entire "$K \vee M$".
- "It is not the case that K or M" is *ambiguous* between "$\sim K \vee M$," and "$\sim(K \vee M)$." Convention: "It is not the case that K or M" $\mapsto$ "$\sim K \vee M$".
- "Not both S and T" $\mapsto$ "$\sim(S \bullet T)$". As we will see later (DeMorgan rule), "$\sim(S \bullet T)$" $\approx$ "$\sim S \vee \sim T$". But, "$\sim(S \bullet T)$" $\not\approx$ "$\sim S \bullet \sim T$".
- Similarly, "Not either S or T" $\mapsto$ "$\sim(S \vee T)$". And, (DeMorgan rule again) "$\sim(S \vee T)$" $\approx$ "$\sim S \bullet \sim T$", but "$\sim(S \vee T)$" $\not\approx$ "$\sim S \vee \sim T$".
- Here are some examples involving $\sim$, $\bullet$, and $\vee$ (not, and, or):
  1. Shell is not a polluter, but Exxon is. $\mapsto$??
  2. Not both Shell and Exxon are polluters. $\mapsto$??
  3. Both Shell and Exxon are not polluters. $\mapsto$??

4. Not either Shell or Exxon is a polluter. $\mapsto$??
5. Neither Shell nor Exxon is a polluter. $\mapsto$??
6. Either Shell or Exxon is not a polluter. $\mapsto$??

- Summary of translations involving $\sim$, $\bullet$, and $\vee$ (not, and, or):

Pseudo-Symbolic	**Propositional Logic (PL)**
Not either *A* or *B*.	$\sim(A \vee B)$
Either not *A* or not *B*	$\sim A \vee \sim B$
Not both *A* and *B*.	$\sim(A \bullet B)$
Both not *A* and not *B*.	$\sim A \bullet \sim B$

- DeMorgan rules (we will *prove* these rules later in the chapter):

$$\sim(p \vee q) \approx \sim p \bullet \sim q$$
$$\sim(p \bullet q) \approx \sim p \vee \sim q$$

- But, $\sim(p \vee q) \not\approx \sim p \vee \sim q$ and $\sim(p \bullet q) \not\approx \sim p \bullet \sim q$.

Chapter 6 — Propositional Logic Translations III

English Expression	**PL Operator**
not, it is not the case that, it is false that	$\sim$
and, yet, but, however, moreover, nevertheless, still, also, although, both, additionally, furthermore	$\bullet$
or, unless, either … or …	$\vee$
if … then …, only if, given that, in case, provided that, on condition that, sufficient condition for, necessary condition for (Note: do not confuse antecedents and consequents!)	$\supset$
if and only if (iff), is equivalent to, sufficient and necessary condition for, necessary and sufficient condition for	$\equiv$

Chapter 6 — Propositional Logic Translations IV

- A Bunch of Translation Problems:
  1. California does not allow smoking in restaurants.
  2. Jennifer Lopez becomes a superstar given that *I'm Real* goes platinum.
  3. Mary-Kate Olsen does not appear in a movie unless Ashley does.
  4. Either the President supports campaign reform and the House adopts universal healthcare or the Senate approves missile defense.
  5. Neither Mylanta nor Pepcid cures headaches.
  6. If Canada subsidizes exports, then if Mexico opens new factories, then the United States raises tariffs.
  7. If Iraq launches terrorist attacks, then either Peter Jennings or Tom Brokaw will report them.
  8. Tom Cruise goes to the premiere provided that Penelope Cruz does, but Nicole Kidman does not.

9. It is not the case that either Bart and Lisa do their chores or Lenny and Karl blow up the power plant.
10. N'sync winning a grammy is a sufficient condition for the Backstreet Boys to be jealous, only if Destiny's Child getting booed is a necessary condition for TLC's being asked to sing the anthem.
11. Dominos' delivers for free if Pizza Hut adds new toppings, provided that Round Table airs more commercials.
12. If evolutionary biology is correct, then higher life forms arose by chance, and if that is so, then it is not the case that there is any design in nature and divine providence is a myth.
13. Kathie Lee's retiring is a necessary condition for Regis's getting a new co-host; moreover, Jay Leno's buying a motorcycle and David Letterman's telling more jokes imply that NBC's airing more talk shows is a sufficient condition for CBS's changing its image.

Chapter 6 — Propositional Logic: Truth Functions I

- Propositional Logic is truth-functional because the truth value of a compound statement is a function of the truth values of its atomic components.
- We use lower-case letters "p", "q", "r", ... to denote statement variables, which can stand for any statement in propositional logic.
- A statement form is an expression (*not* a statement of PL!) constructed out of statement variables and PL connectives which becomes a statement of PL if (simple) statements of PL are substituted for all statement variables.
  - *e.g.*, $p \bullet (q \vee r)$ is a statement form, since $A \bullet (B \vee C)$ is a statement.
  - Note: $(A \vee B) \bullet ((C \equiv D) \vee (E \supset \sim F))$ is *also* of the form $p \bullet (q \vee r)$. Why?
- With this basic terminology out of the way, we're ready to give a precise account of the truth conditions (*i.e.*, the meaning) of PL statements.
- All statement forms are defined by truth tables, which tell us how to determine the truth value of molecular statements from the truth values of their atoms.

Chapter 6 — Propositional Logic: Truth Functions II

- We begin with negations, which have the simplest truth functions. The truth table for negation is as follows (we use T and F for true and false):

p	$\sim p$
T	F
F	T

- In words, this table says that if p is true than $\sim p$ is false, and if p is false, then $\sim p$ is true. This is quite intuitive, and corresponds well to the English meaning of "not". So, truth-functional (PL) negation is like English negation.
- Examples:
  - It is not the case that Wagner wrote operas. ($\sim W$)
  - It is not the case that Picasso wrote operas. ($\sim P$)
- "$\sim W$" is false, since "W" is true, and "$\sim P$" is true, since "P" is false (like English).

Chapter 6 — Propositional Logic: Truth Functions III

p	q	$p \bullet q$
T	T	T
T	F	F
F	T	F
F	F	F

- Notice how we have four (4) rows in our truth table this time (not 2). This is because there are four possible ways of assigning truth values to p and q.
- The truth-functional definition of $\bullet$ is very close to the English "and". A PL conjunction is true if *both* conjuncts are true; and, it is false otherwise.
  - Monet and van Gogh were painters. ($M \bullet V$)
  - Monet and Beethoven were painters. ($M \bullet B$)
  - Beethoven and Einstein were painters. ($B \bullet E$)
- "$M \bullet V$" is true, since both "M" and "V" are true. "$M \bullet B$" is false, since "B" is false. And, "$B \bullet E$" is false, since "B" and "E" are both false (like English).

Chapter 6 — Propositional Logic: Truth Functions III

p	q	$p \vee q$
T	T	T
T	F	T
F	T	T
F	F	F

- The truth-functional definition of $\vee$ is not as close to the English "or". A PL disjunction is true if *at least one* disjunct is true; and, it is false otherwise.
- In English, "*A* or *B*" often implies that "*A*" and "*B*" are *not both true*. That is called *exclusive* or. In PL, "$A \vee B$" is *not* exclusive; it is *inclusive* (it is true if both disjuncts are true). But, we *can* express exclusive or in PL. How?
  - Either Jane austen or René Descartes was novelist. ($J \vee R$)
  - Either Jane Austen or Charlotte Bronte was a novelist. ($J \vee C$)
  - Either René Descartes or David Hume was a novelist. ($R \vee D$)
- The first two disjunctions are true because at least one their disjuncts is true, but the third disjunction is false, since both of its disjuncts are false.