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CHAPTER 1: THE FOUNDATIONS: LOGIC AND PROOF

1.1 PROPOSITIONAL LOGIC
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CONSTRUCTING PROPOSITIONS

Propositional Variables: $p, q, r, s, \ldots$

The proposition that is always true is denoted by T and the proposition that is always false is denoted by F.

Compound Propositions; constructed from logical connectives and other propositions

- Negation $\neg$
- Conjunction $\wedge$
- Disjunction $\vee$
- Implication $\rightarrow$
- Biconditional $\leftrightarrow$

CONNECTIVES: CONJUNCTION

The conjunction of propositions p and q is denoted by $p \wedge q$ "p *and* q" and has this truth table:

p	q	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F

Example: If p denotes "I am at home." and q denotes "It is raining." then $p \wedge q$ denotes "I am at home and it is raining." However, we may also use "but" instead of "and". "I am home, but it is raining".

MORE ON IMPLICATIONS

In $p \rightarrow q$ there does not need to be any connection between the antecedent or the consequent. The "meaning" of $p \rightarrow q$ depends only on the truth values of p and q.

These implications are perfectly fine, but would not be used in ordinary English.

- "If the moon is made of green cheese, then I have more money than Bill Gates. "
- "If 1 + 1 = 3, then your grandma wears combat boots."

One way to view the logical conditional is to think of an obligation or contract.

- "If I am elected, then I will lower taxes."
- "If you get 100% on the final, then you will get an A."

If the politician is elected and does not lower taxes, then the voters can say that he or she has broken the campaign pledge. Something similar holds for the professor. This corresponds to the case where p is true and q is false.

PR.3: IMPLICATIONS

Give the converse, inverse and contrapositive of the conditional statement:

Prof. B is happy when you get your homework done on time.

Rewrite: If you get your homework done on time, then Prof. B is happy

p q

Converse $q \rightarrow p$

If Prof. B is happy, then you got your homework done on time

Inverse $\neg p \rightarrow \neg q$

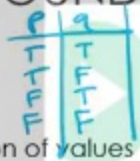
If you did not get your homework done on time, Prof. B is not happy

Contrapositive $\neg q \rightarrow \neg p$

TRUTH TABLES FOR COMPOUND PROPOSITIONS

Construction of a truth table:

p, q, r



Rows

- Need a row for every possible combination of values for the compound propositions.

Columns

- Need a column for each propositional variable
- Need a column for the truth value of each expression that occurs in the compound proposition as it is built up
- Need a column for the compound proposition (usually at far right)

Order of Operations

Operator	Precedence
¬	1
∧	2
∨	3
→	4
↔	5

COMPOUND PROPOSITION TRUTH TABLE WALK-THRU

5. Fill in the truth table for your propositions first. Now complete the table. Try it on your own first!

p	q	r	$p \vee q$	$\neg r$	$p \vee q \rightarrow \neg r$
T	T	T	T		
T	T	F	T		
T	F	T	T		
T	F	F	T		
F	T	T	T		
F	T	F	T		
F	F	T	F		
F	F	F	F		

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