Discrete MATH

Logic, Graphs & Trees, Sets, Probability

Logic of Statements

Statements & Logical Connectives

A **statement** is a sentence that is either true or false, but not both.
EX: The moon orbits the Earth is a true statement.
EX: One plus one equals three is a false statement.

A **compound statement** is a statement that is made up of one or more simple statements using **logical connectives**.

For statements p and q, the table summarizes the logical connectives that can be used to create compound statements.

Logical Connectives		
Expression	How it is read	Type of connective
~p	"not p"	negation
p ∧ q	"p and q"	conjunction
p ∨ q	"p or q"	disjunction

Compound statements may contain multiple logical connectives. For compound statements that contain a negation (~) and another logical connective, the negation (~) is performed first.
EX: ~p ∨ q is equivalent to (~p) ∨ q.
EX: ~p ∧ ~q is equivalent to (~p) ∧ (~q).

You can express compound statements symbolically using ~, ∧, and ∨.
EX: Let p represent the statement "It is cloudy." Let q represent the statement "It is raining." Represent each compound statement below symbolically.
It is not raining. ~q
It is cloudy and it is raining. p ∧ q
It is cloudy but it is not raining. p ∧ ~q or p ∧ (~q)
It is not cloudy and it is not raining. ~p ∧ ~q or (~p) ∧ (~q)

Truth Tables

A **statement** is either true or false and has a well-defined **truth value**. Compound statements also have well-defined truth values that are determined by the truth values of the simple statements that comprise them. **Truth tables** can be used to show the truth value of a compound statement based on the truth values of its components.

EX: Negation of a statement
For a statement p, the negation of p is written ~p and means "not p." The truth value of ~p is the opposite of the truth value of p. If p is true, then ~p is false. If p is false, then ~p is true.

p	~p
T	F
F	T

EX: Conjunction of a statement
For statements p and q, the conjunction of p and q is written p ∧ q and means "p and q." The truth value of a conjunction is true when, and only when, both p and q are true. If either p or q is false, or if both p and q are false, the conjunction is false.

p	q	p ∧ q
T	T	T
T	F	F
F	T	F
F	F	F

EX: Disjunction of a statement
For statements p and q, the disjunction of p and q is written p ∨ q and means "p or q." The truth value of a disjunction is true when at least one of p or q is true. If both p and q are false, then the disjunction is false.

p	q	p ∨ q
T	T	T
T	F	T
F	T	T
F	F	F

Truth tables can also be used to determine the truth values of more complicated compound statements.

EX: Construct a truth table for the compound statement ~p ∨ (q ∧ r).

p	q	r	~p	q ∧ r	~p ∨ (q ∧ r)
T	T	T	F	T	T
T	T	F	F	F	F
T	F	T	F	F	F
T	F	F	F	F	F
F	T	T	T	T	T
F	T	F	T	F	T
F	F	T	T	F	T
F	F	F	T	F	T

Logical Equivalence & De Morgan's Laws

Two statements are logically equivalent if and only if they have identical truth values. The symbol ≡ is used to denote logical equivalence.

Steps to Determine Logical Equivalence

For compound statements P and Q:
1. Construct a truth table for P.
2. Construct a truth table for Q using the same statement variables as step 1.
3. Compare the truth values of the tables. If the truth values in each row are the same, the statements are logically equivalent. If the tables have a different truth value in any row, the statements are not logically equivalent.

De Morgan's laws are used to determine the negation of a conjunction and the negation of a disjunction.

The negation of a conjunction is logically equivalent to a disjunction in which each component is negated.

~(p ∧ q) ≡ ~p ∨ ~q

EX: Find the negation of the statement Justine is a sophomore and has blonde hair.
The negation of this statement is Justine is not a sophomore or does not have blonde hair.

The negation of a disjunction is logically equivalent to a conjunction in which each component is negated.

~(p ∨ q) ≡ ~p ∧ ~q

EX: Find the negation of the statement Luis was sick on Monday or he missed the school bus.
The negation of this statement is Luis was not sick on Monday and he did not miss the school bus.

As with other compound statements, a truth table can be used to demonstrate the logical equivalence of De Morgan's laws.

EX: Construct a truth table to show that ~(p ∨ q) ≡ ~p ∧ ~q.

p	q	~p	~q	(p ∨ q)	~(p ∨ q)	~p ∧ ~q
T	T	F	F	T	F	F
T	F	F	T	T	F	F
F	T	T	F	T	F	F
F	F	T	T	F	T	T

Conditional Statements

A **conditional** statement is an if-then statement of the form "if p, then q," where p is the **hypothesis** and q is the **conclusion**. This is symbolized by p → q or read as "p implies q."

EX: If 12 is divided by 4, then the quotient is 3.
If Nathan makes the soccer team, then he will play fullback.
If Christy does not earn at least a B on her final, then she will earn a C for the class.

A conditional statement is false when, and only when, the hypothesis p is true and the conclusion q is false. Otherwise, the conditional statement is true.

p	q	p → q
T	T	T
T	F	F
F	T	T
F	F	T

Truth tables can be used to analyze compound conditional statements.

Guide For Discrete Mathematics

Gerard O'Regan

Guide For Discrete Mathematics:

Guide to Discrete Mathematics Gerard O'Regan,2016-09-16 This stimulating textbook presents a broad and accessible guide to the fundamentals of discrete mathematics highlighting how the techniques may be applied to various exciting areas in computing The text is designed to motivate and inspire the reader encouraging further study in this important skill Features provides an introduction to the building blocks of discrete mathematics including sets relations and functions describes the basics of number theory the techniques of induction and recursion and the applications of mathematical sequences series permutations and combinations presents the essentials of algebra explains the fundamentals of automata theory matrices graph theory cryptography coding theory language theory and the concepts of computability and decidability reviews the history of logic discussing propositional and predicate logic as well as advanced topics examines the field of software engineering describing formal methods investigates probability and statistics **A Beginner's Guide to Discrete Mathematics** W.D. Wallis,2013-03-14 This text is a basic introduction to those areas of discrete mathematics used by stu dents of mathematics and computer science Introductory courses on this material are now standard at many colleges and universities Usually these courses are of one semester s duration and usually they are offered at the sophomore level Very often this will be the first course where the students see several real proofs The preparation of the students is very mixed and one cannot assume a strong back ground In particular the instructor should not assume that the students have seen a linear algebra course or any introduction to number systems that goes beyond college algebra In view of this I have tried to avoid too much sophistication while still re taining rigor I hope I have included enough problems so that the student can reinforce the concepts Most of the problems are quite easy with just a few dif ficult exercises scattered through the text If the class is weak a small number of sections will be too hard while the instructor who has a strong class will need to include some supplementary material I think this is preferable to a book at a higher mathematical level which will scare away weaker students **Discrete Mathematics and Graph Theory** K. Erciyes,2021-01-28 This textbook can serve as a comprehensive manual of discrete mathematics and graph theory for non Computer Science majors as a reference and study aid for professionals and researchers who have not taken any discrete math course before It can also be used as a reference book for a course on Discrete Mathematics in Computer Science or Mathematics curricula The study of discrete mathematics is one of the first courses on curricula in various disciplines such as Computer Science Mathematics and Engineering education practices Graphs are key data structures used to represent networks chemical structures games etc and are increasingly used more in various applications such as bioinformatics and the Internet Graph theory has gone through an unprecedented growth in the last few decades both in terms of theory and implementations hence it deserves a thorough treatment which is not adequately found in any other contemporary books on discrete mathematics whereas about 40% of this textbook is devoted to graph theory The text follows an algorithmic approach for discrete mathematics and graph problems where

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