proposition: predicate w/o quantifier is not a proposition (i.e. x = 0 w/o for all/there exists x is not a proposition) rows = 2^n, n = num of predicates
nega: ***always*** negate quantifiers $\neg\forall x\ to\ \exists x$ when writing out translation
quantifier/logic translation: ***always*** use: $\forall x\big(P(x) \rightarrow Q(x)\big)\ and\ \exists x\big(P(x) \wedge Q(x)\big)$
quantifier scoping: $\forall x\ \exists y\ for\ all\ x\ there\ is\ at\ least\ one\ y, doesnt\ have\ to\ be\ the\ same\ y$
$\exists y\ \forall x\ there\ is\ only\ one\ y\ for\ all\ x, is\ the\ same\ y\ for\ all\ x$
Distributing quantifier:
Nested quantifier: demorgan is done one layer after another: $\neg\forall x\forall y\forall z P(x) \equiv \exists x\neg\forall y\forall z P(x) \equiv \exists x\exists y\exists z\neg P(x)$
Only $\wedge\ and\ \vee$ distribute
Useful demorgans/equivalence laws:
De Morgan's Law for quantifiers:

TABLE 2 De Morgan's Laws for Quantifiers.

Negation	*Equivalent Statement*	*When Is Negation True?*	*When False?*
$\neg\exists x P(x)$	$\forall x \neg P(x)$	For every x, $P(x)$ is false.	There is an x for which $P(x)$ is true.
$\neg\forall x P(x)$	$\exists x \neg P(x)$	There is an x for which $P(x)$ is false.	$P(x)$ is true for every x.

De Morgan's Law: $\neg(p \wedge q) \equiv \neg p \vee \neg q, \neg(p \vee q) \equiv \neg p \wedge \neg q$
Definition of →: $p\ \leq q\ \equiv T, p\ > q \equiv F$
Idempotent Laws: $p \vee p \equiv p, p \wedge p \equiv p$
Distributive Law: $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r), p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$
Absorption Laws: $p \vee (p \wedge q) \equiv p, p \wedge (p \vee q) \equiv p$, this is because ∨ only needs at most one to be true
Impl breakout/contrapos: $p\ \rightarrow q\ \equiv \neg p\ \vee q\ \equiv \neg q\ \rightarrow \neg p$ (***always breakout first to simplify stuff***)
Nega impl: $\neg(p \rightarrow q) \equiv p\ \wedge \neg q$

TABLE 7 Logical Equivalences Involving Conditional Statements.

$p \rightarrow q \equiv \neg p \vee q$
$p \rightarrow q \equiv \neg q \rightarrow \neg p$
$p \vee q \equiv \neg p \rightarrow q$
$p \wedge q \equiv \neg(p \rightarrow \neg q)$
$\neg(p \rightarrow q) \equiv p \wedge \neg q$
$(p \rightarrow q) \wedge (p \rightarrow r) \equiv p \rightarrow (q \wedge r)$
$(p \rightarrow r) \wedge (q \rightarrow r) \equiv (p \vee q) \rightarrow r$
$(p \rightarrow q) \vee (p \rightarrow r) \equiv p \rightarrow (q \vee r)$
$(p \rightarrow r) \vee (q \rightarrow r) \equiv (p \wedge q) \rightarrow r$

TABLE 8 Logical Equivalences Involving Biconditional Statements.

$p \leftrightarrow q \equiv (p \rightarrow q) \wedge (q \rightarrow p)$
$p \leftrightarrow q \equiv \neg p \leftrightarrow \neg q$
$p \leftrightarrow q \equiv (p \wedge q) \vee (\neg p \wedge \neg q)$
$\neg(p \leftrightarrow q) \equiv p \leftrightarrow \neg q$

Tautology/must be true $A(x) \wedge (\neg A(x) \vee A(x)) \equiv A(x)$
Contradiction/must be false $p\ \wedge \neg p$
Satisfiable/can have one case to be true

counterexamples think:
$\forall x\exists y(y^2 = x)[x, y \in R]$, false, x cannot be < 0(should also check for zero)
$\forall y\exists x(y = 3x)[x, y \in Z]$, false, $y = 1$, x can be a fraction.
$\exists x\forall y(y = 3x)[x, y \in Z]$, false, $x = 4, y = 1{,}2{,}3{,}203$

Proof 101:
always prove/disprove for all instead of there exists, then let vars be arb. type of num
to disprove P(x)=prove $\neg P(x)$(is true)

Proof:
by contradiction: seeking contradiction, assume the (negation), there is a contradiction, thus original is true
by cases: blah, then (WLOG) all cases exhausted
by contrapos: assume contrapo

truth table finding: if mostly false, then its $\wedge + add\ \neg$, ; if mostly true, then its $\vee + add\ \neg$; if its half false & true, then its ⟺

Sets:
Cardinality: num of elements in a set. Just be careful with which one gets subtracted from
Power set: every single possible combos of sets including $\{\emptyset\}$
disjoint sets
minus: $A\ -\ B = in\ A\ but\ not\ in\ B$
Sets proof 101:
Subset method: show that each side of the identity is a subset of the other side.
Proper subset: $A\ \subset B\ \wedge A\ \neq\ B$, A is a subset of B, and A and B are not the same set.
Inclusion-exclusion principle: Only applies to cardinality
$|A \cup B \cup C|(thisistotal) = |A| + |B| + |C| - |A \cap B| - |A \cap C| - |B \cap C| + |A \cap B \cap C|$

More counterexamples for rational / irrational $x = \sqrt{2}, y = \sqrt{2}, x \times y = 2$, which is irrational times irrational making a rational

Counterexamples for positive / negative, $x = 0$

Prime numbers > 2 are odd. Or prime numbers only divide themselves and 1.

Tautology can always be satisfiable.
Satisfiable cannot always be tautology.

Madeleine's OH equations:$x \in \overline{(B \cap A)} \equiv x \in (\overline{B} \cup \overline{A}) \equiv x \notin (B \cap \mathrm{A}) \equiv x \notin B \vee x \notin A$

TABLE 1 Set Identities.

Identity	*Name*
$A \cap U = A$ $A \cup \emptyset = A$	Identity laws
$A \cup U = U$ $A \cap \emptyset = \emptyset$	Domination laws
$A \cup A = A$ $A \cap A = A$	Idempotent laws
$\overline{(\overline{A})} = A$	Complementation law
$A \cup B = B \cup A$ $A \cap B = B \cap A$	Commutative laws
$A \cup (B \cup C) = (A \cup B) \cup C$ $A \cap (B \cap C) = (A \cap B) \cap C$	Associative laws
$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$ $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$	Distributive laws
$\overline{A \cap B} = \overline{A} \cup \overline{B}$ $\overline{A \cup B} = \overline{A} \cap \overline{B}$	De Morgan's laws
$A \cup (A \cap B) = A$ $A \cap (A \cup B) = A$	Absorption laws
$A \cup \overline{A} = U$ $A \cap \overline{A} = \emptyset$	Complement laws