Predicate Logic
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\textbf{Definition}: Let $x$ be a variable with domain $D$. A \textit{predicate} $P(x)$ is a statement that has a truth value (True or False) for each value of $x$ in $D$.

\textbf{Definition}: the \textit{universal quantification} of $P(x)$ is the proposition: "$P(x)$ for all values of $x$ in the domain of $x$."]

This is denoted by the notation $\forall x \ P(x)$, which is read “for all $x$, $P$ of $x$” (or “for every $x$, $P$ of $x$”).

\textbf{Definition}: \textit{the existential quantification} of $P(x)$ is the proposition: "There exists an element in the domain of $x$ such that $P(x)$."  

This is denoted by the notation $\exists x \ P(x)$, which is read “there exists an $x$ such that $P$ of $x$.”
Statements Using Quantifiers

Universal quantifiers typically tie with implications.

- All P(x) is Q(x) \[\forall x \ P(x) \rightarrow Q(x)\]
- No P(x) is Q(x) \[\forall x \ P(x) \rightarrow \neg Q(x)\]

Existential quantifiers typically tie with conjunctions.

- Some P(x) are Q(x) \[\exists x \ P(x) \land Q(x)\]
- Some P(x) are not Q(x) \[\exists x \ P(x) \land \neg Q(x)\]
DeMorgan's Laws for Quantifiers

\nalways
\neg \exists x \, P(x) \equiv \forall x \, \neg P(x)

\neg \forall x \, P(x) \equiv \exists x \, \neg P(x)