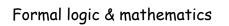


# Symbolic Logic

- Symbolic logic can be used for three basic needs of formal logic
  - To express propositions,
  - To express the relationship between propositions, and
  - To describe how new propositions can be inferred from other propositions that are assumed to be true

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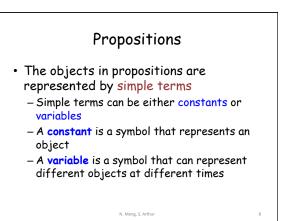
- Most of mathematics can be thought of in terms of logic
- The fundamental axioms of number and set theory are the initial set of propositions, which are assumed to be true
- Theorems are the additional propositions that can be inferred from the initial set

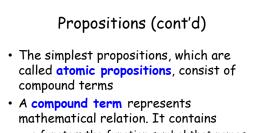
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## First-Order Predicate Calculus

- The particular form of symbolic logic that is used for logic programming is called first-order predicate calculus
- It contains propositions and clausal form

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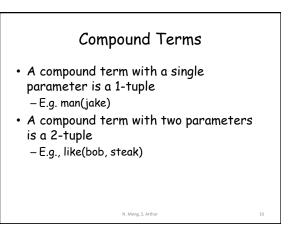




- a functor: the function symbol that names the relation, and

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– an ordered list of parameters



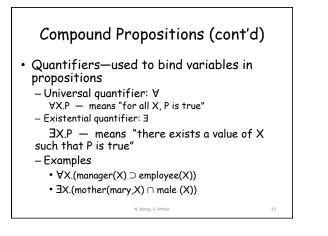
# Compound Terms

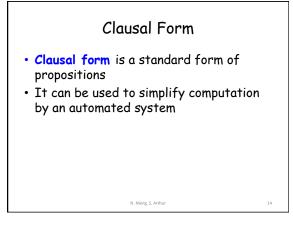
- All of the simple terms in the propositions, such as man, jake, like, bob, and steak, are constants
- They mean whatever we want them to mean - E.g., like(bob, steak) may mean
  - Bob likes steak, or
  - steak likes Bob, or
  - Bob is in some way similar to a steak, or
  - Does Bob like steak?
- Propositions can also contain variables, such as man(X)

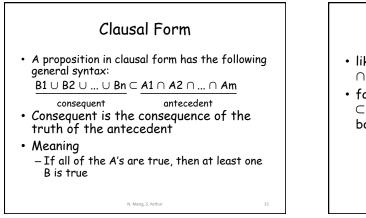


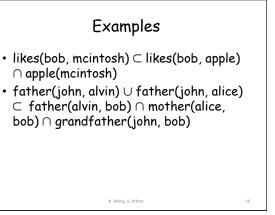
• Atomic proposition(s) are connected by logical connectors

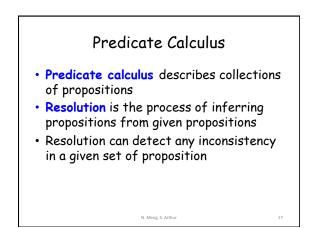
Name	<u>Symbol</u>	<u>Example</u>	<u>Meaning</u>
negation	7	¬a	not a
conjunction	$\cap$	$a \cap b$	a and b
disjunction	U	a∪b	a or b
equivalence	=	a = b	a is equivalent to b
implication	$\supset$	a⊃b	a implies b
	$\subset$	$a \subset b$	b implies a
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older(terry, jon) ⊂ mother(terry, jon) wiser(terry, jon) ⊂ older(terry, jon)

 We can infer the proposition: wiser(terry, jon) ⊂ mother(terry, jon)

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### Horn Clauses

- When propositions are used for resolution, only Horn clauses can be used
- A proposition with zero or one term in the consequent is called a Horn clause
  - If there is only one term in the consequence, the clause is called a Headed Horn clause
    - E.g., person(jake) ⊂ man(jake)
    - For stating Inference Rules in Prolog
  - If there is no term in the consequence, the clause is called a Headless Horn clause
    - E.g., man(jake)
    - For stating **Facts and Queries** in Prolog

#### Logic Programming Languages

- Logical programming languages are declarative languages
- Declarative semantics: It is simple to determine the meaning of each statement, and it does not depend on how the statement might be used to solve a problem
  - E.g., the meaning of a proposition can be concisely determined from the statement itself

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# Logic Programming Languages (cont'd) Logical Programming Languages are nonprocedural Instead of specifying how a result is computed, we describe the desired result and let the computer figure out how to compute it

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# An Example

 E.g., sort a list sort(new\_list, old\_list) ⊂ permute(old\_list, new\_list) ∩ sorted(new\_list) sorted(list) ⊂ ∀j such that 1 ≤ j < n, list(j-1) ≤ list(j)
 where permute is a predicate that returns true if its second parameter is a

true if its second parameter is a permutation of the first one

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# Key Points about Logic Programming

- Nonprocedural programming sounds like the mere production of concise software requirements specifications

   It is a fair assessment
- Unfortunately, logic programs that use only resolution face the problems of execution efficiency

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- The best form of a logic language has not been determined
- Good methods of creating programs in logic programming languages have not yet been developed

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