Al-Mustaqbal University
College of Science

KNOWLEDGE REPRESENTATION

1st CLASS / AI BRANCH

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Lecture 3

2- Predicate Logic (Calculus) (Also known as First-Order Logic)

To solve the limitation in the propositional calculus, you need to analyze propositions into predicates and arguments and deal explicitly with quantification. *Predicate Logic* provides formalism for performing this analysis of propositions and additional methods for reasoning with quantified expressions.

For example, instead of letting a single prepositional symbol, **P**, denotes the entire sentence "**it rained on Tuesday**", we can create predicate **weather** that describes a relationship between a **date** and the **weather**:

rain (weather, tuesday)

through inference rules, we can manipulate predicate calculus expression accessing their individual components and inferring new sentences. Predicate calculus also allows expressions to contain variables. Variables let us create general assertions about classes of entities. For example, we could state that for all values, of X, where X is a day of the week, the statement:

rain (weather, X) is true ;

I.e., "**it rains every day**". As with propositional calculus, we will first define the syntax of the language and then discuss its semantics.

Example: *Represent the following knowledge using the predicate logic method:*

1-Facts

1- Maha is a girl
girl(maha)

2- I have a book
have (i, book).

3- Ali is a brave man
brave (ali,man).
brave (ali) ^ man (ali)

4- Ali has red car
has (ali,car) ^ color(car,red)

5- This is sunny day

sunny(day).

6- Maha has 4 books

has(maha, book) ^ number (book,4)

7- Ali going to school now

go(ali, school) ^ time(now)

8- I have one or two books

have (i, book) ^ (number(book,1) V number(book,2))

have (i, book) ^ (number(book,1) V (book,2)) Wrong

9- Nobody likes taxies

¬ ∃X like(X, taxi)

¬ ∀X like(X, taxi) Wrong

10- There is a person who writes computer class

∃X write(X, computer class)

11- John did not study but he is lucky

¬ study(john) ∧ lucky(john)

12- Either Jack or Sarah wrote homework.

write (jack, homework) ∨ write (sarah, homework)

13- Animals either male or female.

∀X male (X) ∨ female (X)

Example: *Represent the following knowledge using the predicate logic method:*

2- Rules

1- If its winter then it is cold

winter(weather) → cold(weather)

2- When I'm sick, I will go to the doctor

sick(i) → go (i, doctor)

3- If student will read well, he will pass

read(X, well) → pass(X).

4- Ahmed goes to school when he is 6 years old

age (ahmed,6) → go(ahmed, school).

5- If it is raining, tom will not go to the mountain

$rain(weather) \rightarrow \neg go(tom, mountain)$

6- All basketball players are tall

$\forall X \quad play(X, basketball) \rightarrow tall(X)$

7- John likes anyone who likes books

$like(X, book) \rightarrow like(john, X)$

8- All dogs are animals

$\forall X \quad dog(X) \rightarrow animal(X)$

9- All cats and dogs are animals

$\forall X \forall Y \quad cat(X) \wedge dog(Y) \rightarrow animal(X) \wedge animal(Y)$

$\forall X \forall Y \quad cat(X) \wedge dog(Y) \rightarrow animal(X \wedge Y)$ Wrong

10- Ali eats anything john eats

$$eat(john, X) \rightarrow eat(ali, X)$$

11- John playing well therefore he will win the game

$$play(john, well) \rightarrow win(john, game)$$

12- There are no two adjacent countries have the same color.

$$\forall X \forall Y \, (county(X) \wedge county(Y) \wedge adjacent(X,Y)) \rightarrow \neg (color(X) \equiv color(Y)).$$

13- All blocks supported by blocks that have been moved have also been moved.

$$\forall X \forall Y \; block(X) \wedge block(Y) \wedge support(X,Y) \wedge move(X) \rightarrow move(Y)$$