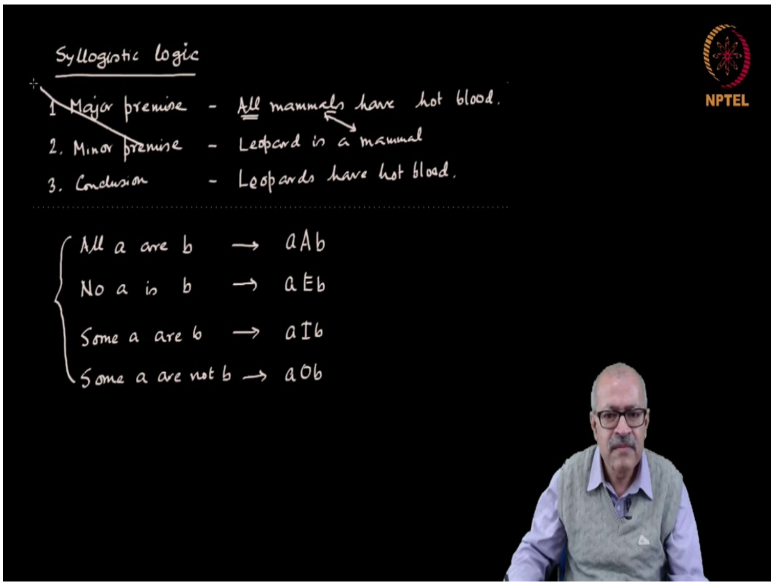
Research Methodology

Prof. Soumitro Banerjee
Department of Physical Sciences
Indian Institute of Science Education and Research, Kolkata

Lecture - 10
Logical Reasoning: Syllogistic Logic Part 01

(Refer Slide Time: 00:17)



We are now coming to Syllogistic Logic or syllogism as sometimes it is called. This was almost entirely the contribution of Aristotle. Other people added to that, but the structure was laid by Aristotle.

He said that, whenever you are trying to apply deductive logic, always structure your argument, your logic, your thought process, in a very specific grammatical way, which will allow you to distinguish between wrong logical structure and correct logical structure.

And he laid out the rules and laws of such grammatical structure. For example, his point was that, if I have a premise given, then on that basis I should be able to logically infer what can definitely be inferred as fact.

So, the structure is that: if this is true, that is definitely true. What we can infer like that? He said that whenever we start, we start from some kind of a general premise and we make a statement about a particular situation.

The general premise is called the ‘major premise’. So, 1st is the major premise—the major premise is the general situation—and a minor premise, the particular situation, and then on that basis we draw the conclusion. The major premise and minor premise—both have to have a well-defined structure.

For example, we can say something like ‘all mammals have hot blood’, and then a minor premise, a particular situation, is that ‘leopard is a mammal’, and then on that basis we can conclude the leopards have hot blood.

Even without testing whether all leopards have hot blood or not, you can arrive at that conclusion because the general conclusion that all mammals have hot blood is true. And how did you arrive at this conclusion that all mammals have had hot blood? By applying inductive logic.

Scientists have examined various mammals and in all cases they have found hot blood. Therefore, they said that, unless an exceptional situation is found, it is reasonable to conclude that all mammals have hot blood.

Notice that in case of any application of deductive logic, such a prior inductive inference is necessary. Without that, you cannot apply deductive logic. That is why, out of these two lines of logic: inductive and deductive, inductive is said to be prior, because without having some inductively obtained premise, you cannot really apply deductive logic.

Now, let us look at the structure. Here we have something like ‘all’ statement. Mammals have hot blood—this is of the structure of ‘all a are b’: all mammals have hot blood. That kind of statement we are making. And then we are saying that a particular thing is in this category, and therefore we are able to make an inference.

In the major premise there is a subject, that is ‘mammal’. There is a predicate, that is ‘hot blood’. In the minor premise there is a subject, ‘leopard’, and there is a predicate, ‘a mammal’. And notice that when we are drawing the conclusion, the subject of the minor premise comes first, the predicate of the major premise comes next, and this term, called middle term, gets eliminated. So, ultimately, we do not have the middle term in the conclusion. That is the structure of a logical argument.

So, he made the point that all deductive reasoning must follow this grammatical structure. That means, the major premise must have a subject and a predicate. The minor premise must have a subject and a predicate. And when you draw the conclusion, it will say something about the subject of the minor premise.

And what it says comes from the predicate of the major premise, and in between something gets eliminated: the subject of the major premise and the predicate of the minor premise. And then he showed that this kind of statements can have four possible structures. ‘All’ is one of them. This statement is actually of the shape that ‘all A are B’. I will use small letters, all a are b.

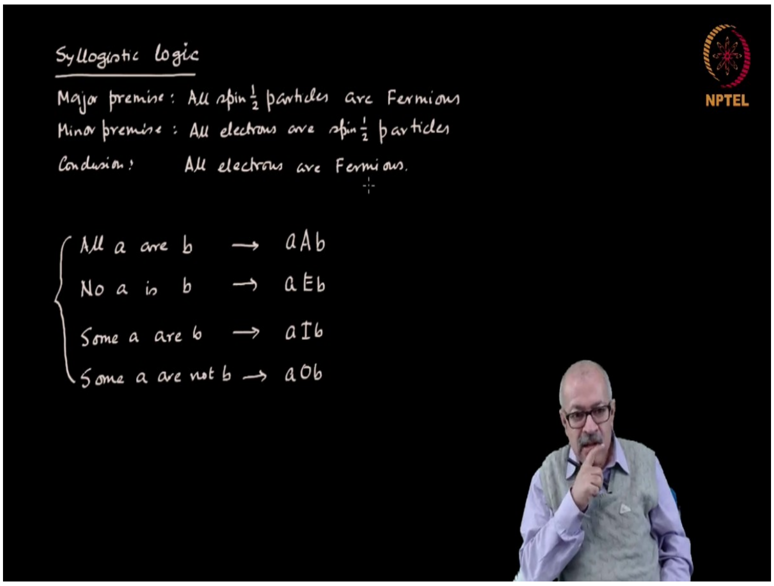
So, all mammals have hot blood, b is the character of having hot blood. So, ‘all’ — that is one kind of statement. You can have ‘no a is b’. That is another kind of statement that you can have. You can also have ‘some a are b’ and then ‘some a are not b’. These are the four types of statements you can make, which makes logical reasoning a lot simplified because there are only four structures possible in making a major premise and minor premise.

So, he said that all statements that you make on the basis of which you are trying to obtain some logical deduction, they have to be stated in either of these forms. And then he said that if there are only four such structures, we can abbreviate them. So, he said that let us abbreviate this as aAb. So, it is a sort of abbreviated structure of this ‘all a are b’.

Similarly, this is again between a and b; a ‘no’ is given as E. These letters come from the Greek alphabets. ‘Some’ is given as aIb and ‘some not’ is given as aOb. Therefore, statements can be made in an algebraic form: ‘all a are b’ is just written as aAb; ‘no a is b’ is written as aEb, and so on and so forth. And then you can, independent of what a and b are stated to be, you can find out what are logically valid.

And then whatever a and b are, these will simply be substituted there and logical conclusions can be obtained. So, it is a great simplification of the act of forming logical structures and that is how he proceeded. Let me give one example.

(Refer Slide Time: 10:34)



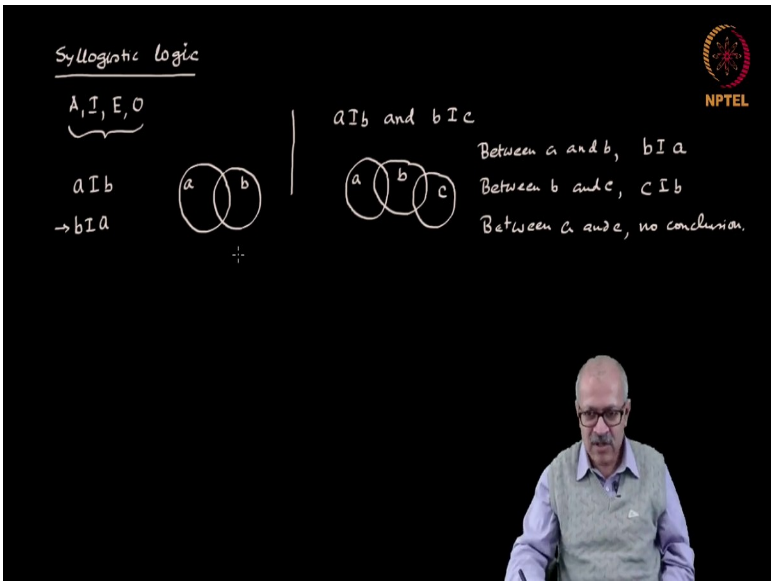
So, major premise is that 'all spin-half particles are fermions'. Minor premise: 'all electrons are spin half particles' and then conclusion: 'all electrons are fermions'. Notice that here again all the statements are of the 'all' type, the first type. Again, 'spin half particles' is the middle term and this is what gets eliminated. This is the subject of the minor premise which comes first, predicate of the major premise come second, and that is how you form the conclusion. So, this way he suggested that we form our conclusions.

I will give some examples. The example that Aristotle himself gave is that 'all men are mortal', 'Greeks are men' and therefore, 'Greeks are mortal'. So, here this logical structure is the same. And one can then form a series of such deductions.

The way I have shown earlier that there can be a series of logical deductions, you can also have series of syllogistic logical deductions. Where the predicate of one becomes the subject of the next, the predicate of that becomes the subject of the next, the predicate of that becomes the subject of the next, and so on and so forth. Ultimately you are able to link between the subject of the last and the predicate of the first.

That way we can produce a series of reasonings, ultimately arriving at something that is far removed from where you started. To give a rather simple example: 'all lions are big cats', 'all big cats are predators' and 'all predators are carnivores'. From that you can conclude that all lions are carnivores. Simple example, but you can easily see that this way we can produce more complicated logical structures.

(Refer Slide Time: 14:29)



Now, Aristotle and many other ancient logicians showed that with these four types A, I, E and O, you can have 256 combinations in total, and out of that, only 24 would lead to valid reasoning. And they listed those valid reasonings. Now, today we do not need to go into that, I mean memorizing the list of those 24 that are valid reasonings. Rather, we can do it using the modern method of drawing Venn diagrams.

For example, suppose you have a premise given as aIb, I means ‘some’. So, if I draw a Venn diagram, it will be a blob of a and a blob of b, with some overlap. ‘Some a are b’, and on that basis what can we conclude? We can conclude that ‘some b are a’. So, this is easy. Right? This is a valid inference and similarly we need to go ahead and try to infer various things.

For example, if the given premises are aIb and bIc, then we have a situation where I can draw a blob of a and I know that there is a overlap with b. Therefore, this. And now we need to draw the c blob. But we do not know. It only says that there is a overlap between b and c. Therefore, it could be here, it could also be here. Right? Which means that the given premises do not talk about whether or not there is a overlap between a and c. So, we can draw it like this, but this is not the only way to draw it.

Therefore, whenever we make the statement regarding what we can conclude out of that, we have to say: between a and b, we can say that aIb was given, bIa is true (I is ‘some’), bIa is true. A is true between b and c. bIc was given and naturally cIb is also true, and between a and c, you can have no conclusion actually.

So, you need to be careful about what the premises actually give and you should not assume what the premises do not give. And so, even though you can conclude that there may be a possibility of some overlap between a and c, but you cannot infer that, that is true. So, whenever you are asked to have some kind of a guaranteed conclusion, something that will definitely be true, then you have to say that there is no conclusion.

But, if you are asking whether or not a possibility of an overlap between a and c exists, yes, the possibility exists. So, you can state it as a possibility.

I will go ahead with this kind of logical structures and I will illustrate some of the valid logical reasonings, but you have to go ahead. These are not the exhaustive ones. I will not go into the exhaustive ones, but I will illustrate some more of these logical structures in the next class.