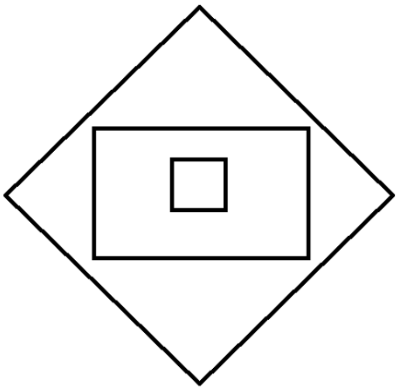
Go Higher Module 4- Logical Statements

Uncertain, unstructured situations can be simplified with logical statements. You can express the relationship between two events using the statements. The dependence between events can be seen with them. Options available to oneself and other players can be identified by using logical statements.

We will start our discussion on logical statements with a basic example from geometry.

Simply put, a quadrilateral is a four-sided figure. A rectangle is a quadrilateral with opposite sides equal and parallel, as well as each angle a right angle. A square is a rectangle with all sides equal.



The outermost figure is a quadrilateral. Within that, there is a rectangle. The innermost figure is a square.

So, all rectangles are quadrilaterals, and all squares are rectangles.

We can see that:

1. If we have a square, we have a rectangle.
2. If we have a rectangle, we have a quadrilateral.
3. If we have a square, we have a quadrilateral.

These observations are of the type- "If X, then Y". X and Y can denote any variable or event. This is the first logical statement we will discuss. [Note that 'All X are Y' can be written as 'If X, then Y.']

Taking the first observation i.e. "If we have a square, then we have a rectangle", what is the derivation we can make that must be true? We can say that "If we don't have a rectangle, we don't have a square."

The following results are logically possible, though not necessarily true:

- "If we have a rectangle, we have a square." (i.e.If Y, then X)
- "If we don't have a square, then we don't have a rectangle." (i.e.If not X, then not Y)

We can see this from the diagram. A rectangle has to have all sides equal and only then can be called a square. And we can have rectangles that are not squares.

Hence, the consistent meaning of the statement "If X, then Y." is "If not Y, then not X." From this, we can understand that an event X is a condition that can cause an event Y. Y must happen if X happens. So, when Y doesn't happen, we can say that X didn't happen either.

It may be that Y can be caused by another condition Z. So, if Y happens, X may or may not have happened. We can have a rectangle without having a square. This would be a quadrilateral with opposite sides equal and parallel, as well as all right angles, but adjacent sides unequal.

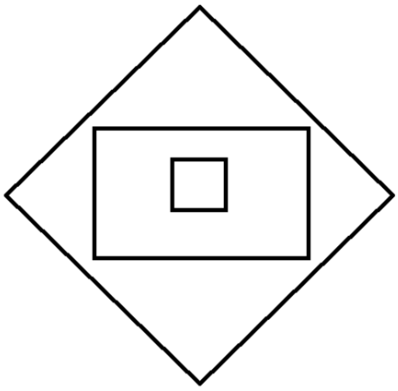
Squares are *sufficient* to have a rectangle. Rectangles are *necessary* to have a square.

The inner set constitutes the 'sufficient condition'. The larger set is the 'necessary condition'.

- A sufficient condition can guarantee an outcome by itself. But there can be other conditions too that are sufficient to make that outcome happen. We can have rectangles without having squares.

- A necessary condition is always needed to guarantee an outcome. However, a necessary condition cannot guarantee an outcome by itself. We must have a rectangle in order to have a square, though there will be more requirements to make it a square like all sides have to be equal.

Sufficient conditions are more valuable than necessary conditions. If we have the sufficient variable, then we have the necessary variable. But the reverse is not always true. Necessary factors do not guarantee a result by themselves. Necessary conditions depend on other variables to guarantee the sufficient condition. Whereas, sufficient variables do not depend on other requirements to ensure the necessary condition.



From this diagram, you can also observe that 'Only if you have a rectangle, then you have a square'. What is the derivation we can make from it that is necessarily true? We can say that "If you don't have a rectangle, you don't have a square."

The necessarily true meaning of the statement, "Only if X, then Y", is "If not X, then not Y". This statement type reflects a situation in which there is a precondition for an event to happen.

A third logical statement is of the type- "Either X, or Y." X and Y are the choices available. This statement means that *at least* one of the alternatives is true.

Let us say in a recruitment process, the candidate to be selected must either have 5 years' experience *or* an MBA degree. (Note that it is possible for a candidate to possess both requirements.) Hence, the following statements are true:

1. If a selected candidate does not have 5 years' experience, they have an MBA degree.
2. If a selected candidate does not have an MBA degree, they have 5 years' experience.
3. If a selected candidate has 5 years' experience, they may or may not have an MBA degree.
4. If a selected candidate has an MBA degree, they may or may not have 5 years' experience.

In some cases, there will be a condition of exclusivity – only one alternative will be possible. Here, the form of the premise needs to be "Either X, or Y, *and only one*." For this premise, valid conclusions would be that 'If X is chosen, Y is not chosen.' and 'If Y is chosen, X is not chosen.'

The last logical statement we will discuss is "X unless Y." When one says, 'I will die unless I breathe', it means that breathing is one of the necessary conditions to live. The logically consistent conclusion of the statement is 'If I do not breathe, I will die.' So, we see that "X unless Y" means "If not Y, then X."