Venn diagram: Simple and multiple use for establishing validity of arguments

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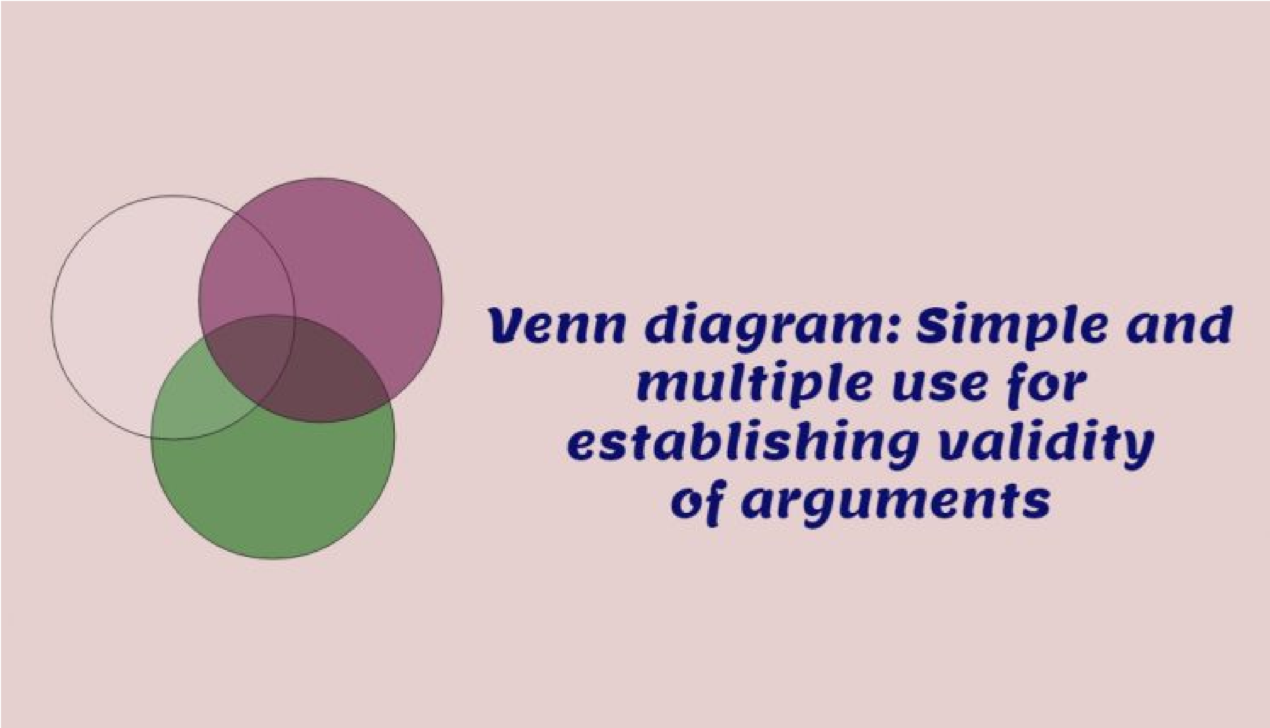

This topic brings out the important part of categorical syllogism, which helps to determine the validity of arguments. In this blog post, we have tried to cover the basic concepts of Venn Diagrams along with the steps of validating the arguments with the help of rules /sets of arguments.

The standard dictionary meaning of the argument is "Discussion where there is disagreement".

In other words, we can say; if the conclusion of an argument is guaranteed, the argument is valid and if it's not guaranteed the argument is invalid.

Saying that an argument is valid does not mean that the conclusion is true: We verify the situation by an example. Consider two premises 1. All doctors are men, 2. My mother is a doctor. Then the valid argument "My mother is a man" is not a true conclusion.

Saying that an argument is invalid does not mean that the conclusion is false. We verify the situation also by an example. Consider two premises 1. All professional wrestlers are actors, 2. The Rock is an actor. Then the invalid argument "the Rock is a professional wrestler", may not be false.

We will verify valid and invalid arguments and conclusions with Venn diagram.

Let’s get started …

What are Venn diagrams?

A Venn diagram uses overlapping circles or other shapes to illustrate the logical relationships between two or more sets of items. Often, they serve to graphically organize things, highlighting how the items are similar and different.

Venn diagrams are named after British logician John Venn.

Venn diagrams, also called Set diagrams or Logic diagrams, are widely used in mathematics, statistics, logic, teaching, linguistics, computer science and business. Many people first encounter them in school as they study math in set theory syllabus.

Venn diagram use cases

1. **Math**: Venn diagrams are commonly used in school to teach basic math concepts such as sets, unions and intersections.
2. **Statistics and probability:** Statistics experts use Venn diagrams to predict the likelihood of certain occurrences. This ties in with the field of predictive analytics. Different data sets can be compared to find degrees of commonality and differences.
3. **Logic**: Venn diagrams are used to determine the validity of particular arguments and conclusions. In deductive reasoning, if the premises are true and the argument form is correct, then the conclusion must be true.

Deductive Logic and Validity

Let’s first understand the concept of the validity of deductive arguments.

Deductive arguments are arguments wherein the conclusion is necessarily true (assuming true premises and a valid form).

In other words, it is impossible to have a situation where:

(1) the premises of the argument are true, and

(2) the form of the argument is valid, and

(3) the conclusion is false.

The reason for this is very simple: the conclusion of a deductive argument does not contain any new information –it is already contained (in some implicit form) in the premises itself.

Example –

An example of an argument using deductive arguments:

1. All men are mortal. (First premise)
2. Socrates is a man. (Second premise)
3. Therefore, Socrates is mortal. (Conclusion)

The first premise states that all objects classified as “men” have the attribute “mortal.” The second premise states that “Socrates” is classified as a “man” – a member of the set “men.” The conclusion then states that “Socrates” must be “mortal” because he inherits this attribute from his classification as a “man.”

[Source – Wikipedia]

Further, we can see from the above that the concept of validity is very important for deductive arguments. The conclusion is guaranteed to be true only if the form of the argument is valid and the premises are true. Also, NOTE: validity and invalidity apply **only to deductive arguments**. Inductive arguments are neither valid nor invalid.

Testing Validity Using Venn’s Diagrams

So, what is validity? Questions of validity are purely formal. In testing for validity, we are not in any way concerned with the actual content of an argument. We are only concerned with its form –the way in which the premises are supposed to provide support for the conclusion.

This is usually performed with the help of abstraction step to the replacement of particular content with variables (In Most Cases Alphabets such as A, B, C, D…) and arrange them in the same specific form.

Let’s talk above example again –

1. All men are mortal. (First premise)

2. Socrates is a man. (Second premise)
3. Therefore, Socrates is mortal. (Conclusion)

Note the content of argument we are talking about – > Men = (A), Mortal = (B) and Socrates = (C).

Now arranging the variable in the same form: –

1. All A Are B
2. C is A
3. Therefore C is B.

Once we have the argument translated into the variable form we are going to ask a simple question: given that the premises are true, does the conclusion necessarily follow?

If you have categorical syllogisms, then you test this question by using Venn Diagrams. If you have compound statements using logical operators, then you use Truth Tables. We are going to look only at Venn Diagrams here, but the basic principle is the same: assuming that the premises are true, does the conclusion necessarily follow?

Venn Diagrams types and Validity

In most of the examination, the question asked from this topic will be based on 2 or 3 term arguments.

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As there are some severe limitations to their usefulness as the number of terms grows. First, while it is possible to construct a 16 region Venn-type diagram for a 4 term argument, and even a 32 region diagram for a 5 term argument, those diagrams are almost impossible to read or use. What is more, it is impossible to construct a 64 region diagram for a 6 term argument–there is no way to get exactly the right 64 regions in a 2-dimensional diagram

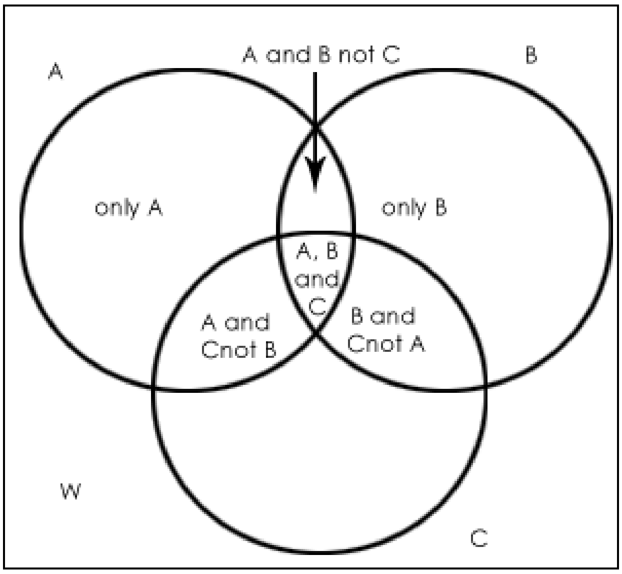
You must remember the old school formula –

$n(A \cup B) = n(A) + n(B) - n(A \cap B)$
$n(A \cup B \cup C) = n(A) + n(B) + n(C) - n(A \cap B) - n(B \cap C) - n(C \cap A) + n(A \cap B \cap C)$

To test the validity of a categorical syllogism, one can use the method of Venn diagrams. Since a categorical syllogism has three terms, we need a Venn diagram using three intersecting circles, one representing each of the three terms in a categorical syllogism.

A three-term diagram has eight regions (the number of regions being 2n where n is the number of terms).

So far in the NET Examination, we have seen question-based on CATEGORICAL SYLLOGISM so we will restrict our details for solving the Categorical Syllogism based question only.



Covering the entire concept of Syllogism is beyond the scope of this article and we would see only important concepts such as –

1. Four (and only four) basic categorical claims.
2. Diagramming Categorical Syllogisms (DCS) & Some rules of translation along with shading an area
3. And Finally; Validate the argument.

Remember –

Four Types of basic categorical claims.

1. **Universal Affirmative. – Example- all humans are animals (This is not reversible relationship)**
2. **Universal Negative. – Example- No A Are B (Note that this is reversible:e. No B Are A is also true)**
3. **Particular Affirmative. Example- Some humans are rational)**
4. **Particular Negative. Example – Some humans are not reptilian**

Diagramming Categorical Syllogisms (DCS).

Heads up! You can use various online available tool to create *Venn diagram*

Canva's Venn diagram maker is the easiest way to make a Venn diagram online. Start by choosing a template – they've got hundreds of Venn diagram examples to choose from. With a suite of easy to use design tools, you have complete control over the way it looks.

[Source – Canva]

Step 1-

First, translate the argument into a categorical structure. This involves identifying the categories that are being related to one another, and the manner of relation (Universal Affirmation, Universal Negation, Particular Affirmation, and Particular Negation).

The key to categorical syllogisms is to identify the categories being used. This is often seen that the given premise is not straight forward to identify and this require practice. On the whole, this process is rather simple and with practice, you will become an expert at it.
Step 2 –
Replace categories with variables.[See example above]

Step 3 –

Then, after step two, we are ready for the process of diagramming. The process of diagramming is again very simple. We use overlapping circles to represent the various categories and their interrelation. Since all categorical syllogisms will have three (and only three) categories, there will always be three circles.

Shading and Putting and X

Shading is only used when dealing with All and No claims (Universal affirmation and negation), putting an X is used only when dealing with Some are and some are not claims (Particular affirmation and negation).

In step three we shade the area where all the ALL or NO claims found in the argument, note that you should always start with ALL and NO claims.

Step 4 –

In step four we put 'X' in the area where the 'Some' or 'Some are NOT' claims found in the argument, note that you should always start with ALL and NO claims.

Step 5 –

Now, you check for validity. Note, that you only diagram the premises. After having diagramed the premises, the conclusion should be evident. If it is not evident, if you have to do more work to make the conclusion evident, then the argument is clearly invalid.

So, Determining Validity with Venn Diagrams works through

- Diagram the premises
- Look to see if the conclusion is true in the resulting diagram

If the conclusion is true in the diagram, the syllogism is valid; if not, not.

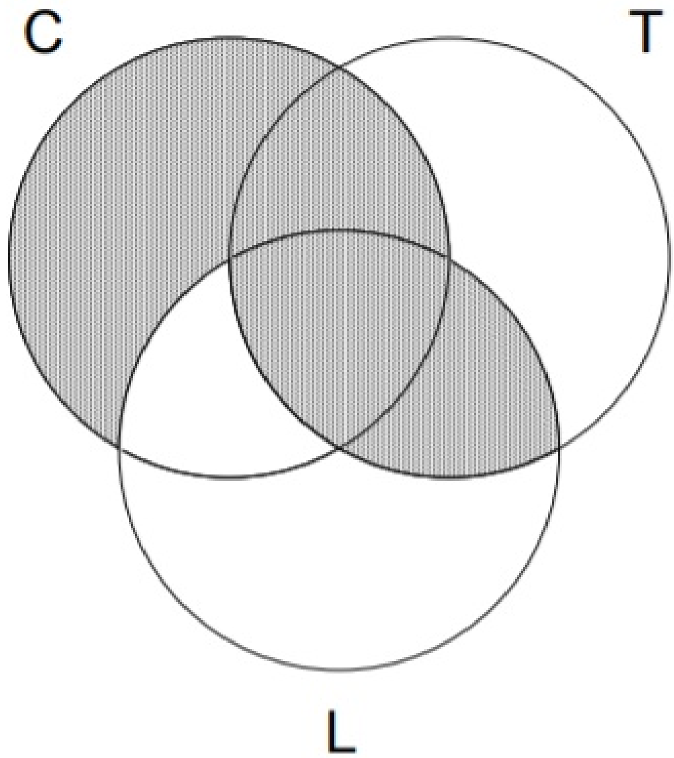
Solved Example

1. *People who shave their legs don't wear ties.*
2. *All cyclists shave their legs.*
3. *Therefore, no cyclist wears a tie.*

Let's put them in Standard form and replace with variables

1. *No leg shavers are tie wearers. – No L Are T*
2. *All cyclists are leg shavers. – All C are L*
3. *Therefore, no cyclists are tie wearers. – Therefore No C are T*

If both our premises are universal, as in this argument, we can diagram either premise first. So let's diagram the minor premise:



Venn diagram: Simple and multiple uses for establishing the validity of arguments.

Now we look to see if the content of the conclusion is already there

But we see that the shaded region here was shaded automatically when we diagrammed the premises. So the argument is valid.

Heads up! There is another type of question-based on the formula of Sets and Venn Diagrams were asked previously so its worth to add here.

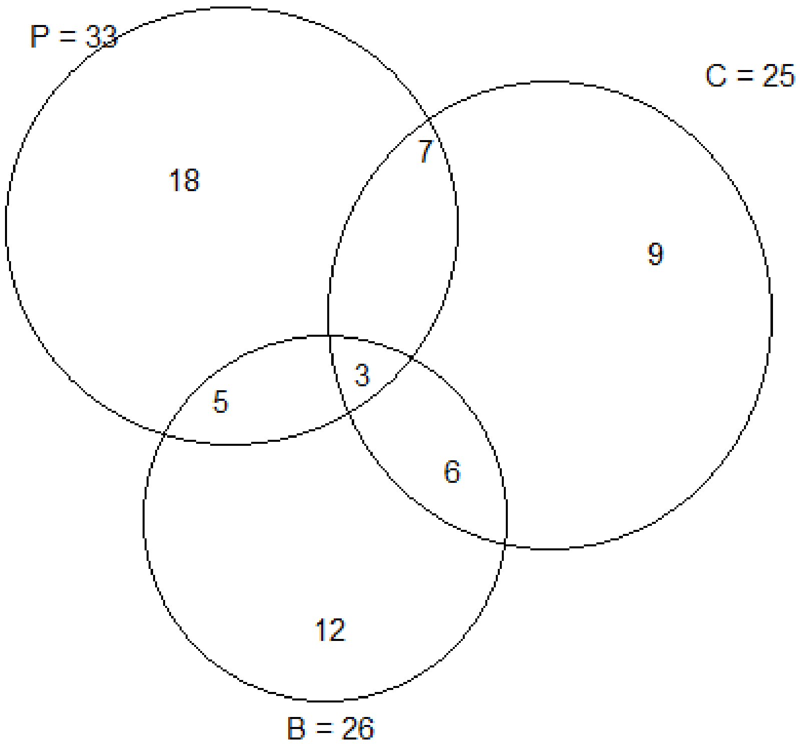
Question: A school has 63 students studying Physics, Chemistry and Biology. 33 study Physics, 25 studies Chemistry and 26 Biology. 10 study both Physics and Chemistry, 9 study Biology and Chemistry, while 8 study both Physics and Biology. Equal numbers study all three subjects as those who learn none of the three. How many students study all three subjects?

1. 2
2. 3
3. 5

4. 7
5. 8

From the given problem above, it is a Venn Diagram Problem because it involves the intersection or mutual items of the sets. Consider the figure below

Venn diagram problem
P only=33-18-x
B only =26-17-x
C only =25-19-x
15-x+9-x+6-x+8+10+9+x=63
-2x=63
X=-3
Which means you have to work with 3 in the middle



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