Traditional logic, going back to Aristotle and before, spent much time and energy working out an intricate systematization of the logic of categorical statements and "syllogisms", a.k.a. arguments. In this tutorial, we will address these syllogisms but use Venn Diagrams to circumvent the intricacies.

Let's begin with an example of a categorical syllogism:

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No mammals are fish.
All whales are mammals.
So, no whales are fish.
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Makes sense, yes? Try this one...

```
All whales are mammals.
No fish are whales.
So, no fish are mammals.
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OK? Well anyway, these are two examples of categorical syllogisms. But only one of the two is valid...how do we tell? Venn Diagrams.

1. Let's see categorical syllogisms how are defined. Each consists of two premises, both of categorical form, and one categorical statement as conclusion.

   The conclusion is of the form: "All/No/Some $S$ are $P$" (choose one quantity word from the three types). Each premise contains one of the category terms, $S$ or $P$, from the conclusion. In addition, there is a "middle term", $M$, in both premises. So, in the first argument above...

   ```
   No mammals are fish.
   All whales are mammals.
   So, no whales are fish.
   ```

   $S$ is "whales" and $P$ is "fish" (see the conclusion) while the middle term, $M$, is mammals. Note that $M$ is the one category term in both premises.

2. Because there are three terms in our syllogisms, our diagrams will be a little more complicated. We'll need three circles to represent the three groups.
Notice that the possibilities of overlap are increased. We could continue to talk about these in terms of their colors. Now there's an orange area that is inside the M and P circles but outside S. Right? This means that any objects in orange are in category M and P but they are non-S.

But it's better to have numbers:

Now, instead of "orange" we can just say 6.

The important thing is what it means to be in an area. Anything in area 3 is just P, it is neither M nor S.

Now let's see how we put these to work.

Here's that first categorical syllogism again:

No *mammals* are fish.
All *whales* are *mammals*.
So, no *whales* are *fish*.

Instead of writing out the whole category description, sometimes they get quite long!, we'll just do letters. So, let's rewrite this as

No *M* are *F*.
All *W* are *M*.
So, no *W* are *F*.

Now we just do the Venn Diagram by diagramming what the premises mean together...the argument will be valid if the premises mean that the conclusion is true.
...way of diagramming. The only difference is that now we have a third category in the way.

Here goes, let's first take our Venn Diagram with numbers...

and diagram the first premise.

The first premise is "No M are F". To say what it means for this to be true, we just exclude everything in the area of overlap between M and F.

This is just what we did before. Here it means that areas 5 and 6 are completely empty. We use our stakeout to show this. Do it now.

Next we diagram the second premise right over the top of the first diagram. "All W are M" means that there is nothing in W outside of M: something can't be a whale without also being a mammal. OK? So, diagram this in the normal way, just strike-out the areas 1 and 2 because both of these areas would, if non-empty, contain whales that are not mammals. Do it now.

What do all these stripe mean? Well, the are of overlap of W and F is marked off. So, our premises together mean that there is nothing that is both W and F: No Whales are Fish. This is to say that the premises are enough. If they are true, then the conclusion "No W are F" must be. So, this argument is valid.

Here's the test of validity:

1. Diagram both premises.
2. Stop diagramming and see if premises together indicate that the conclusion is true.
3. If they do make the conclusion true, then the argument is valid. Otherwise, it's invalid.
Now which of the following diagrams is right for our second argument?

All whales are mammals.
No fish are whales.
So, no fish are mammals.

Click on the Venn Diagram below for this argument. Feedback is shown below the diagrams.
OK, second argument...

All whales are mammals.
No fish are whales.
So, no fish are mammals.

...is correctly diagrammed by the first option (to the left).

The first premise is diagrammed with the nearly horizontal stripes (like these: "---") and the second premise is diagrammed with the nearly vertical stripes (the ones which look like this:
\[ /\)\].

But, there is something wrong here. Or, I should say, something wrong with the argument above. It's *not* valid. Let's see why.

The point of the diagram is to spell out exactly what the two premises together mean. Our two premises tell us that there can be *nothing* in areas 4, 5, and 7. But this fact, the emptiness of the areas of 4, 5, and 7, is not enough to make the conclusion true.

![](No%20fish%20are%20mammals.png)

For this conclusion, we'd need to have 5 and 2 excluded. But 2 is not. The premises allow that some *non-*whales be fish that are mammals. So, the argument is not valid, the premises (alone) do not make the conclusion inescapable.

Again, here's how we evaluate an argument:

1. Diagram both premises.
2. Stop diagramming and see if premises as diagrammed indicate that the conclusion is true.
3. If they do make the conclusion true, then the argument is valid. Otherwise, it's invalid.

Because at 3 we determined that the diagram of the premises do not make the conclusion true, so the argument is invalid.

Here's another argument and it's diagram.


All whales are mammals.
All mammals are vertebrates.
So, all whales are vertebrates.

The argument sounds right, but is it? Click on the correct description.

1. Valid
2. Invalid
3. Indeterminate

So this argument is valid. And sound to boot: its premises are true. Let's make sure we see why...

The Venn diagram for the syllogism is a diagram for the premises only. But, for any valid argument like this one, we can see that the conclusion is true as well. This last point is clearer if we keep in mind what the diagram for the conclusion, "all whales are vertebrates." looks like:

This diagram for the conclusion alone shows that there are no whales outside the yellow vertebrate circle. This is true of our diagram of the syllogism above: areas 1 and 4 have the strike-out.

But the diagram on the left says nothing about area 2. That's OK. The diagram for the whole syllogism says much more than that all whales are mammals. But part of
what is says is that there is no whale that is not a mammal, hence it does imply the conclusion of the argument. That's all we need to show validity.

Another way to make the point is this: The diagram of the conclusion "all whales are vertebrates." says nothing about the are in green. There are no marks in this green area, so the diagram is neutral about the existence or non-existence of things that are both whales and vertebrates. Only if we put a letter in an area do we know that there is something there. And only if we put strike-out in an area do we know that there is nothing there.

Existential Statements in the Diagram for a Syllogism

It's easy to diagram existential statements for a syllogism too. But there is one trick we'll see in a moment. To make life simpler, always diagram any non-existential statement before an existential one. We'll see why in a moment.

Here's a good argument to diagram:

| Some fish are not carnivores. |
| All whales are carnivores.    |
| So, some whales are not fish. |

Step 1: Diagram the premises (leaving the existential premise to last).

So, first diagram the universal premise to get this:

Now, we'll diagram the existential premise. Because this is a negative existential, i.e., the predicate is "not a carnivore" which we read as "non-carnivore", we need to put a letter, 'x' inside the fish-circle but outside the carnivore-circle.

We diagram the existential statement last because now we can see that there is only one place to put the the 'x', viz. area 3:

Step 2: So, what conclusion can we draw from this about whales and fish?

We know that some fish (the 'x') is not a whale.
But the diagram does not tell us there is a whale that is a non-fish. Area 4 has no diagramming marks, so it tells us nothing about the existence or non-existence of whales that would be non-fish.

Step 3: So, what can we say about validity? *This argument is...*

1. Valid
2. Invalid
Our argument is *not* valid.

Some fish are not carnivores.
All whales are carnivores.
So, some whales are not fish.

To show the argument valid, the diagram would need to include the information that there is something in area 4 (there would need to be an 'x' marked there).

However, this same diagram is enough to show another argument is valid:

Some fish are not carnivores.
All whales are carnivores.
So, some fish are not whales.

There is one last wrinkle to consider. Begin diagramming this argument:

No M are P.
Some S are non-M.
So, some S are P.

Notice that it won't matter what 'S', 'M', and 'P' are about. This is formal logic. Their content does not matter!

**Step 1:** Because one premise, the first, is *not* existential. So, diagram it first:

The second premise require that we put something, named by 'x', inside S but outside P...
But when we try to place the 'x', there is some uncertainty:

Should we place the 'x' in area 1? Or in area 2? Nothing in the premises tell us where the object or objects should go. It's just that there are some S that are non-M. The best we can do is this:

We just put the 'x' right on the line...this indicates are uncertainty. Or, better, indicates the uncertainty in the premises.

**Step 2:** Because the conclusion of our argument...

No M are P.
Some S are non-M.
So, some S are P.

...is "some S are P" we now notice that the diagram is *uncertain* on its truth. The 'x' is not placed within area 2, so the diagram does not make the conclusion true.

**Step 3:** Hence this argument is invalid.