Logic, probability and programming

What would you do if, at the end of the school assembly, all of the members of the football team had to wait behind for a message and all the people in the maths club had to meet outside the hall in the foyer and you were in both? Would you stand in the doorway, half in and half out of the hall? If you did, you would be part of a human Venn diagram!

Venn diagrams were first put forward by John Venn in 1881 as what he called a 'diagrammatic representation of propositions and reasonings'. In short, he was looking for a good way to draw logic statements instead of writing them all out as complicated sentences.

If you had the three statements:

- I am a member of the football team
- I am a member of the maths club
- I am not a member of the knitting squad

you could represent all of them at once by drawing a circle to represent each of the groups, overlapping them and showing where you sit.
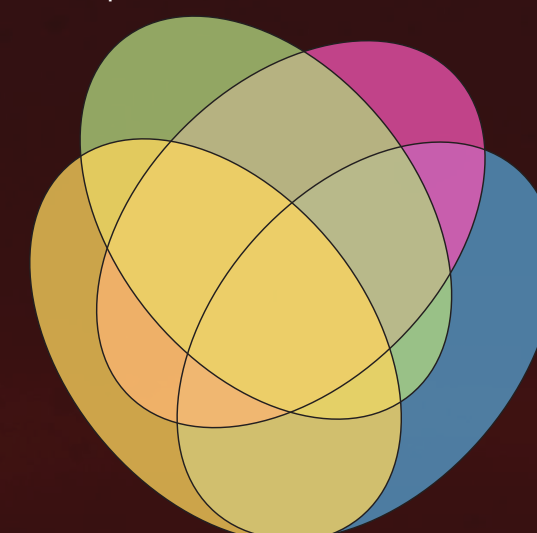
There are eight different regions in this diagram (including the region that is outside of all the circles) so that every combination of which of the groups you are or are not in can be shown. The power of the Venn diagram is that it can take a complicated list of rules about how different objects belong in various groups and convert it into one picture.

In the 1800s a mathematician called Augustus de Morgan stated what are now known as de Morgan's laws and these underpin all of the logical statements that are used in modern computer programs. If you study statistics, you will meet notation to represent a logical statement, such as
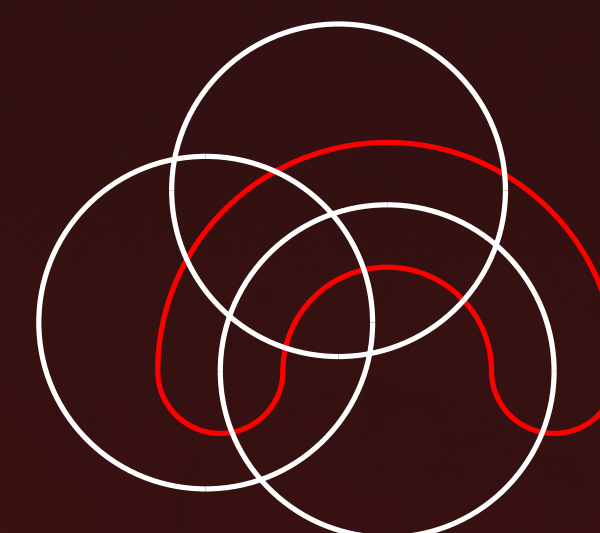
$$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$$

However, this is much easier to follow when it is represented as a Venn diagram. This is exactly what modern computers do when they are processing information according to the rules of logic.
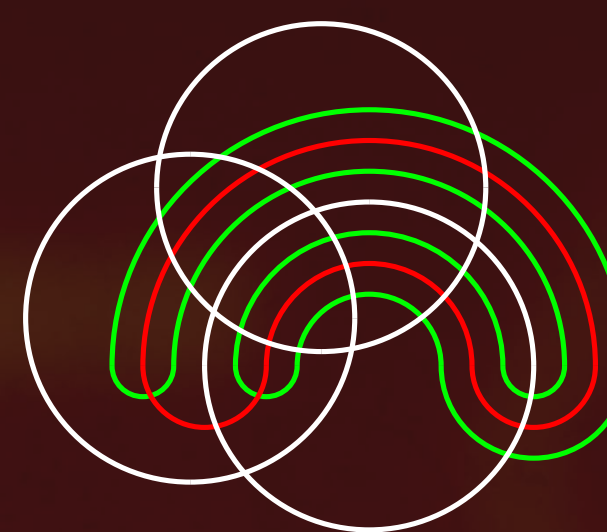

You can draw Venn diagrams for different numbers of sets but, as the number of sets increases, the diagrams become increasingly complicated.
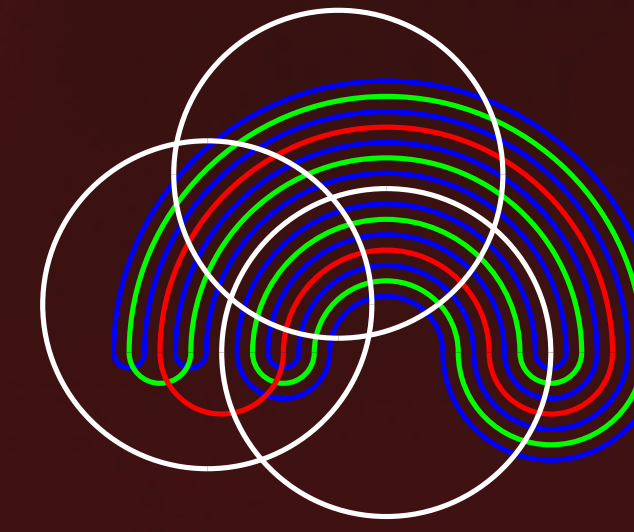

Venn's four-set diagram using ellipses

Venn's construction for 4 sets

Venn's construction for 5 sets

Venn's construction for 6 sets

Genetics

In genetics, it is said that a gene is being expressed if it 'switches on' and starts producing the protein that the gene codes for.

To help understand what the various genes are responsible for it is important to be able to look at which genes are expressed and which aren't in different situations. Geneticists use something called a microarray to analyse a genetic sample and produce a long list of which genes are being expressed. It would be a complicated task to compare the genes that are being expressed in one situation with those being expressed in other situations, but Venn diagrams can come to the rescue! Geneticists can use a computerised Venn diagram program to show them all of the overlapping gene lists.