what's the point of...

# EXPONENTIALS?

## Saving lives with maths

**Many diseases are caused by viruses. In order to help stop the spread of viruses, from those causing the common cold to much more serious ones like HIV, it is necessary to be to able predict how fast they will spread to.**

It is the job of a mathematical biologist to create a mathematical model of how many people can expect to be infected. The spread of many viruses can be modelled by exponentials. This is because the number of people who are infected in any given time period is usually proportional to the number who are already infected.

An accurate model is essential in deciding how to try to contain viruses. Modelling the spread of a virus as exponential growth is especially accurate in the first stages of an outbreak. It is then possible to adapt this to give more accurate predictions as the virus spreads further. These models can be used to test different strategies for dealing with the disease using computer-based simulations. These strategies can include the use of vaccinations, other drugs or even travel restrictions.

Using an accurate model can even help in eradicating viruses completely. The model can be used to predict the proportion of a population that needs to be

vaccinated so that the virus does not spread at all – this is known as herd immunity. Smallpox has been eradicated worldwide by vaccination; polio is likely to be eradicated soon by this method.

A model is only as good as its assumptions (and the mathematics!).

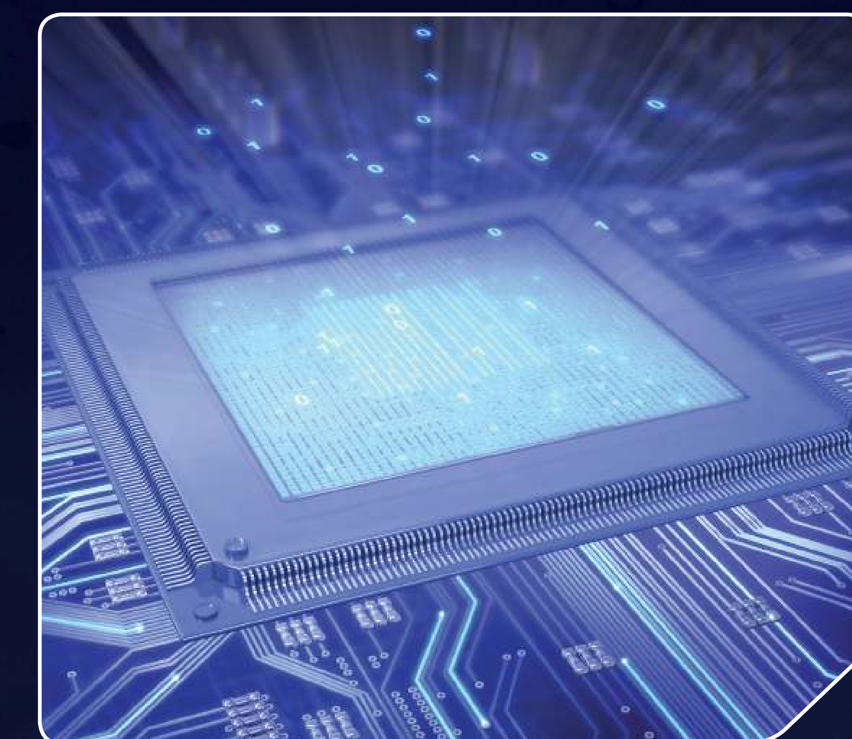
## The pace of change

**In 1965 Gordon E Moore, one of the founders of Intel, suggested that the number of transistors that can be fitted onto a silicon chip doubles every two years. The number of transistors affects many aspects of computing such as power, speed and capacity and consequently all of these qualities have grown exponentially.**

Although the law was first suggested over 40 years ago it still remains accurate today. In 1972 it was feasible to fit 2500 transistors on a silicon chip, by 1974 the figure had doubled to 5000. By 2008 the figure was nearly 2 billion!

The law is now seen as a standard that all producers of computer hardware should try to achieve.

There is much debate about how long the exponential growth predicted by Moore's law can continue. As transistors get smaller and smaller the production techniques required to make the components get more difficult. Some current components are only a few atoms thick and it is possible that as these are reduced further then a limit will be reached. The world



of computing relies on mathematicians and scientists to devise alternative technologies to produce hardware that produces the constant improvements that the modern world has come to rely on.

## Using maths for dating

**It's not just exponential growth that's useful. Exponential decay is too and can be used to estimate the age of ancient objects.**

Carbon-14 is a radioactive isotope of carbon (the more common isotope being carbon-12). The ratio of carbon-14 to carbon-12 in the atmosphere has stayed almost constant for over 50,000 years at about 1 part in a trillion. This is the ratio found in any living plant or animal. Once a plant or animal dies it stops taking in new carbon and the carbon-14 decays radioactively, so the proportion of carbon-14 reduces exponentially. The half-life of carbon-14 is 5730 years. In this time the amount of carbon-14 reduces by a factor of a half. Using this fact the proportion of the carbon in an organic object that is carbon-14 can be used to determine the age of that object.

One famous example of an object that has been carbon-dated is the Turin Shroud. This is a piece of linen cloth found in a chapel in Turin Cathedral in Italy. The cloth appears to show the image of a man who has been crucified. Many people believe that it is the cloth placed around Jesus after his crucifixion. Radio-carbon dating in 1988 showed the cloth to be about 700 years old. There is still much controversy over its true age.


• Written by Tom Button, Peter McOwan, Matt Parker and Zia Rahman
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