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FREQUENCY

At its simplest, the *frequency* of any quantity is the number of times it occurs during an observation period. The word is used most often and with a more specific meaning in physics and electronics, and in statistical analysis. In the former fields, frequency is understood to mean the number of complete cycles of vibration of some observed variable in unit time. It is measured in cps (cycles per second), but the international unit is now called the hertz. The British domestic electricity supply is an alternating current whose frequency is 50 Hz; the musical note A above middle C has a frequency of 440 Hz; the Z80A microprocessor has a clock rate of 4.25 MHz (it performs 4,250,000 primitive machine operations per second); and the BBC's Radio Four broadcasts at a frequency of 94 MHz. The frequency of vibration of wave phenomena such as sound and light is associated with two other quantities – wavelength (the distance between identical points on two consecutive cycles such as peak to peak, for example) and speed of propagation – in the simple relationship:

Speed = Frequency × Wavelength

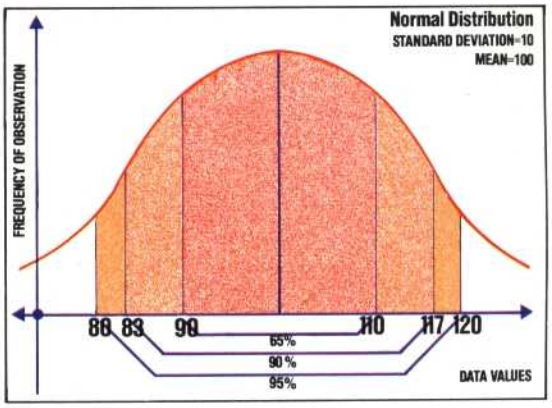
Thus, since electromagnetic radiation (of which visible light, radio and infrared are examples) has an observed speed of propagation of 324,000 km per second, the wavelength of the Radio Four transmissions must be 3.44 metres.

In statistics, frequency refers to the number of occurrences of some quantity in a sample or a population of similar quantities; so, in a sample of 100 British males we might observe that the frequency of occurrence of right-handedness was 87, meaning that 87 people in that sample said that they were right-handed. Statistical analysis depends upon observations of frequency of occurrence, and really derives from the speculations of French scientist Blaise Pascal (1623-62) on the expected frequency of occurrence of the numbers obtained by throwing two dice.

FREQUENCY DISTRIBUTION

If the results of an experiment are plotted on a graph with the results along the x-axis and their frequency of occurrence along the y-axis then the result gives a picture of the *frequency distribution* of those observations. In order to obtain a meaningful distribution it is usually necessary to group the data into sub-classes, and plot the frequency against the sub-classes; if the data group was people's heights in metres, for example, then the sub-classes might be 1.60-1.65 metres, 1.70-1.75 metres, 1.80-1.85 metres, and so on. These distributions can be analysed mathematically, and allow a great deal of descriptive and predictive information to be inferred from what would otherwise be raw data.

A commonly occurring frequency distribution is the *normal* or *Gaussian* distribution: many human attributes are *normally* distributed through the population, such as height, eye colour and (allegedly) intelligence. Many sampling distributions tend to a normal distribution as the sample size tends to infinity.



Give Us A Bell
The commonest frequency distribution – in nature and in theory – is the Gaussian or normal distribution, sometimes known as the bell curve

Any particular sample is characterised by its *mean* (the 'average' value of the sample data) and its *standard deviation* (a measure of the extent to which the sample data differs from the mean value). If the distribution is normal, then approximately 65 per cent of the sample data will differ from the mean value by less than one standard deviation, and over 90 per cent will differ from it by less than two and a half standard deviations. The entire science of statistics is built on this kind of analysis of frequency distributions.

FULL DUPLEX

A telephone line is *full duplex* while a radio link is usually *half duplex*: in the first case data can travel in both directions simultaneously, while in the second case the data travels in only one direction at a time – hence the need to switch from transmit to receive. An even lower level of connection is *simplex* in which data travels in one direction only, with no possibility of reversing the polarity – broadcast radio or television, for example, is a simplex communication.

FUZZY THEORY

In digital systems there are no half-measures, no uncertainty – everything is one or zero, yes or no. This binary logic is necessary at electronic levels, but it has influenced the symbolic logic with which computer programs model the real world. In this, computer thought has departed significantly from those aspects of human thought and logic that are most valuable to us, namely our ability to deal with half-truths and uncertainty, the ability to make decisions on the basis of incomplete data. *Fuzzy logic* attempts to introduce this ability to the computer by constructing a multi-value logic in which a statement may be true, probably true, possibly true, probably untrue, or untrue. This leads to some interesting insights and has so far thrown up such bizarre artefacts as fuzzy sets and fuzzy relationships. As artificial intelligence and research progresses we may expect more developments in this fascinating field.