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Statistical Analysis

Statistical analysis is fundamental to all experiments that use statistics as a research methodology. Most experiments in social sciences and many important experiments in natural science and engineering need statistical analysis.

Human beings are certainly intelligent, and extraordinarily good at detecting patterns and relationships. But there are limits to what we can comprehend intuitively. When trying to uncover the patterns hidden within very large numbers or make sense of data with multiple facets, we need the right tools.

Statistical analysis is precisely the tool to give us approximate solutions when the processes we're interested in are highly complex or unknown in their true forms. In many ways, statistical analysis can often run counter to ordinary human intuition or expectation.

As an example, the study of turbulence relies heavily on statistical analysis derived from experiments. Turbulence is highly complex and almost impossible to study at a purely theoretical level. Scientists therefore need to rely on a statistical analysis of turbulence through experiments to confirm their theories.

Statistical analysis is also at the heart of most social science experiments [1]. Here the task is to arrive at general theories about one of the most complex subjects: human behavior. In the same way as engineers who wish to gain a depth understanding of turbulence, social scientists will use experiments [1] and surveys [2] to flesh out a theory.

For example, consider the age-old question - is there any relationship between money and happiness? What do you think?

A complex question like this is likely to stir debate, but statistical analysis can cut to the heart of things. It turns out that there *is* a direct relationship between money and happiness, but only up to a certain income level (around $60,000/year in the US) after which money and happiness appear independent of each other.

Beware the Pitfalls

All students of science need to understand and be able to employ statistical analysis. The pitfalls are many, however. Statistics can be used, intentionally or unintentionally, to reach faulty conclusions [3]. Highly manipulated claims are unfortunately the norm in advertising and drug companies are notorious for misleading information [4].

Knowledge of statistics will therefore help you see beyond the numbers to grasp the truth. Data dredging [5] is a problem particularly in the internet age where data is easy to come by and many have a vested interest in supporting their own biases. Only by understanding the fundamentals of statistical analysis can one really harness its potential as a tool.

Survey questions are another area that can be very easily manipulated. This occurs right from presidential election surveys to market surveys by corporations. It can even happen unintentionally, which means you need to be even more vigilant when designing your research. Such bias [6] is hard to detect because it doesn't reveal itself directly in the statistics and there is no mathematical technique that will determine whether your question is biased.

It's therefore important that you understand not just the numbers but the meaning behind the numbers. Statistics is a tool, not a substitute for in-depth reasoning and analysis. It should always be understood as a supplement to careful discernment and interpretation.
