You Bet Your Life - Making The Case For The Study Of Probability For All Students[1]

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Which do you feel is the most dangerous: diagnostic X rays; commercial aviation; tobacco; motor vehicles; illegal drugs; hand guns; motorcycles; nuclear power; or alcohol? Think about your answers again after you have examined the data and information presented in this essay.

While it is true that we live in a world of uncertainty, we can easily learn sound techniques and calculation methods that can help us to assess risks, likelihoods, odds, chances, and possibilities. Our understanding of probability and statistics can determine whether we make profitable business decisions or not and whether or not we adopt a healthful life style. A knowledge of probability and statistics can improve the odds with which you bet your life.

The French mathematician Pierre Simon, Marquis de Laplace once asserted that most questions of life are, for the most part, really only problems of probability. While there are those who view the famous marquis' remark to be an exaggeration, probability has become a tool of fundamental importance to nearly all scientists, engineers, medical practitioners, jurists and industrialists (Ross, 1994).

A strong argument can also be made that understanding probability is becoming just as important for individuals in everyday life as it is for the scientific and industrial communities. In Ross's view, the enlightened person should not ask "Is it so?", but rather "What is the probability that it is so?"

The study of probability begins with the concept of a sample space. This concerns ascertaining what are the possibilities. Put another way, clear advantage is gained if we at least know what can happen as opposed to having no idea of the potential events.

For example, suppose you and a friend work for the same company. Suppose, further that you and your friend are two of five people being considered for a promotion, and the company only has 2 promotion slots during this cycle. Assume that all 5 people are equally deserving.

The total number of ways (the sample space size)in which 2 people can be chosen out of 5 is 10. These possibilities are listed below:

S = {(you, friend), (you, person 3), (you, person 4), (you, person 5), (friend, person 3), (friend, person 4), (friend, person 5), (person 3, person 4), (person 3, person 5), (person 4, person 5)}

Note that the paring of you and your friend is but one of these 10 possibilities. Hence, the probability of both you and your friend being promoted is 1 out of 10.

Note that the probability that you will be promoted is 4 out of 10, which is equal to 2 out of 5. This is also true for your friend. The chances that you will be promoted and your friend will not is 3 out of 10. The probability that your friend gets promoted and you do not is also 3 out of 10.

The point of all this is that it is relatively easy to determine these kinds of probabilities if we know the totality of all possibilities. If we do not know the "sample space", we can only guess at the chances.

This illustrates that one should learn at least the rudiments of probability - for peace of mind, if for no other reason. Having peace of mind reduces stress, and medical studies suggest that this reduction my well promote longevity. The above results suggest that you should not have high expectations on both you and you friend being promoted. There is, however, a reasonable chance that at least one of you will be promoted. In fact, that probability is 7 out of 10.

Another situation where it makes sense to be able to calculate the sample space is when making a wager with the lottery. One should know, again, the totality of the possibilities. The chances of hitting a three digit number is 1 in a thousand, since there are 10 possible numbers for each of the three digits. The chances of hitting a four digit number is, therefore, 1 in 10,000.

The chances of hitting a million dollar lottery in Washington D.C., where each of six numbers can be one or two digits up to 49 is, it turns out, one chance in 13,983,816. If you hit, the lottery will pay you $1,000,000. Moreover, you will not get all of the money at once. Typically, the lottery will pay you over a 20 year period (Moore, 1994). Do you think this is a good bet? The calculation of the sample space in this case is a little more complicated, but not overly difficult. A first course in probability would provide the combinatorial experience required to do this calculation.

For case studies that illustrate how to determine the probabilities of winning state lotteries in Connecticut, Pennsylvania, New Jersey, California, and New York, see Johnson, 1992. One of the case studies suggests that while your chances of getting hit by lightning is 1 in 1,000,000, the chances of your winning the Connecticut lottery is about 4 times less likely than that (1 in 3,838,3800), and you are about 14 times likelier to be lightning-struck than to win the California lottery.

The sample space concern comes into play with the concept of investment, particularly investment in the stock mar-

[1] This title comes from Chapter 14 in McGervey (1986). In his book, McGervey lucidly details how knowledge of probability and statistics can enhance our fortunes, help us avoid exploitation, and even contribute to our longevity.

ket. In fact, these probabilities are virtually impossible to calculate accurately because the sample space is constantly changing. Moreover, there is no way to even get a "snap shot" of it. With no stable or enumerable set of possibilities, there is no way to calculate reliable probabilities.

McGervey (1986) says that speculating on the stock market is like a horse race that never ends. At a given point in time one horse is ahead or gaining on others while at another juncture some other is ahead or gaining. There is constant "jockeying". The fact that you are ahead or your stock is going up at one instant does not mean that it will continue to go up. What is worse is that you never know when your "horse" will slow down, speed up or even stop.

While there are many isolated cases of individuals making a "killing" on the stock market, little press is devoted to the countless number of folks who lose far more than they gain. The difficulty has to do with a volatile and dynamic sample space that does not afford you the opportunity to calculate accurate or reliable probabilities.

If one chooses to play the stock market in spite of the lack of probabilistic foundation, a wise strategy might be to invest conservative amounts. Furthermore, maintain an honest and accurate account of gains and losses. In other words, collect ongoing data. And that warrants another plug. Any first course in statistics will enhance you ability to collect and process data.

The study of probability as well as statistics also imparts a better understanding of what is an actual danger as opposed to a perceived one. For example, the probability of dying in a commercial airline accident is about 1 in a million, while the chance of your demise during a transcontinental automobile trip is about 1 in 8,000 (McGervey, 1986).

Statistics can be viewed as the verification arm of probability. As indicated above in the discussion about the stock market, a knowledge of statistics puts us in a position to examine, process and understand data. The importance of this is that you may develop the ability to ignore self-serving, dogmatic or political arguments if you can correctly interpret data for yourself.

For example, there is much debate and controversy about handguns in this country. Consider the data collected on murders with handguns in 1979: 48 in Japan; 34 in Switzerland; 52 in Canada; 58 in Israel; 21 in Sweden; 8 in England; and 10,728 in the United States. (McGervey, 1986) What do these statistics imply to you?

As staggering as these statistics are, the National Institute on Alcohol Abuse and Alcoholism reports that the total number of alcohol-related deaths in the United States per year is well over 100,000. The point is you are much more likely to meet a premature end from your or another persons cocktail than from a handgun. Moreover, disease brought on by the abuse of tobacco, drugs and alcohol accounts for at least a hundred times as many deaths as homicides (Slovic et al, 1980).

As the lottery example of Johnson above indicates, modern courses in probability and statistics are beginning to present an increasing number of case studies as an integral part of the courses. Through these studies and the text material covering basic concepts, we may develop a good understanding about the utility of both probability and statistics, and thus enhance our decision making ability.

Making good decisions has always been important. However, doing so will become more important as world competition intensifies in the 21st century. And, as mentioned above, the study of probability and statistics may help us appreciate the risks involved in various types of behaviors and lifestyles. With the present day expense of medical care, one should be cognizant of and be able to interpret health reports and studies.

For example, a recent cancer statistics review (1973-1991) from the U.S. Department of Health and Human Services indicates that the Lifetime Risk of being diagnosed with some form of cancer for males is about 45% and about 39% for females. These statistics suggest that regular check-ups are warranted, since many forms of cancer can be successfully treated if detected early (Zelen, 1976 & Breslow, 1988).

As a further example, consider a case study reported by M. Sexton and J. R. Sexton in the Journal of the American Medical Association (1984). Their experiment randomly assigned 935 pregnant women smokers into two groups; one continued smoking through pregnancy and the other, the control group, received smoking intervention. From the measured baby weights of these two groups of women, Sexton and Hebel inferred that "Some fetal growth retardation can be overcome by the provision of antismoking assistance to pregnant women". A woman who becomes pregnant and who has taken a statistics course will have an appreciation of studies like this in her knowledge bank to help her decide whether to smoke or not during her pregnancy.

A final point is that the proliferation of data is likely to expand in the next century. An unassailable fact is that data and numerical likelihoods are, have been and will continue in the future to be essential for sound decision making in virtually every aspect of our lives. Statistical literacy empowers one to take control of data and numerical estimates through careful reasoning and interpretation (Moore, 1994). Probabilistic acumen refines our decision making abilities and may ultimately steer us away from risky health activities and dubious financial dealings. It is in these ways that knowledge of probability and statistics can improve the odds with which you bet your life.

In reference to the question initially posed, the things that fit into the most dangerous category are tobacco, alcohol, and illegal drugs. Hand guns, motorcycles and other motor vehicles (cars, trucks, vans, buses, etc) could be classified as moderately dangerous. Commercial aviation, diagnostic X rays and nuclear power could be categorized as relatively safe.

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