Lloyd's of London

This very modern looking building is the home of one of the world's largest commercial insurers, Lloyd's of London founded in 1688. At Lloyd's, like all other insurers, risk is measured in probabilities, which are frequently subjective. Lloyd's differs from other insurers in the kinds of policies they write. Lloyd's has written policies on nuclear reactors, space shuttle cargo, oil tankers, art treasures, kidnap and ransom, as well as the legs of ballerinas and football players.

Insurance has a very important place in commerce, and without it, many business activities would not be possible. If a shipping company could not insure its ships, raising the money to buy them would be virtually impossible. Insurance is big business. In addition to sizable revenues, Lloyd's employs about 2,000 people. Lloyd's is a market, rather than an entity. It houses underwriters who evaluate insurance risk for the syndicates they represent. A syndicate is a group of individuals, called Names, who individually assume a small amount of risk in return for a commensurate portion of the premium. For large policies, like an ocean cargo vessel, even a syndicate does not usually underwrite the entire policy; more often groups of syndicates each take a small percentage–thus further diluting each individual's risk.

Probability, Statistics, and Business

Most of the time, when working with samples, statisticians try to deduce from the samples the population parameters (means, proportions, variances, etc.) of certain variables. This process of making judgments about population parameters is called **statistical inference**.

Statistical Inference

Statistical inference involves the use of sample data to form generalizations or inferences about a population. Using sample data to estimate the values of population parameters is one form of statistical inference.

DEFINITION

Because samples are random, there is no guarantee that the sample will be representative of the population. If the sample is not representative, then using the sample mean as an estimate (inference) of the population mean would not be very wise. Probability is used to assess the quality of our inference. Since statistical inference is an inductive process, all statistical conclusions must be endowed with a degree of uncertainty. Because probability is used to assess the reliability of sample inferences, it is a fundamental element of all inferential statistics.

The probability concept also has many direct applications in business. When a manager wonders whether dropping a bid price by 5% will increase the probability of winning the bid, he or she is thinking about chance. Probability is also used as a criteria in designing and evaluating product reliability, insurance valuation, inventory management, project management, and in the study of queuing theory (a probabilistic analysis of waiting lines).

Probability theory emerged from the need to better understand a game of chance. Business decisions, like games, have uncertain outcomes. In an effort to make better decisions, businesses spend considerable amounts of money trying to quantify uncertainty. This means trying to turn uncertainty into a probability. Insurance companies have historically done a good job quantifying uncertainty. In fact, a special kind of statistician, called an actuary, has emerged to assist in the development of insurance models which quantify uncertainty and aid in business decisions.

The next time you watch a 30-second commercial during the Super Bowl, consider the fact that a company has just spent on average $6.5 million for the airtime plus a substantial amount of money developing the advertisement. Without knowing the effect of the advertisement in advance, extensive amounts of money are put at risk with an uncertain outcome. The manager making the decision to invest in the advertisement uses subjective probability to assess the risk and reward.

6.1 Exercises

Basic Concepts

1. Describe randomness.
2. What is probability?
3. List the necessary conditions for a random experiment.

4. What is an outcome? What is an event?
5. What are the two approaches to objective probability?
6. What are some of the problems associated with the relative frequency approach?
7. What is the Law of Large Numbers?
8. Describe the classical approach to probability.
9. Which of the concepts of probability would be most closely associated with the term "empirical probability"?
10. What is statistical inference?
11. Discuss the relationship between probability and statistics.

Exercises

12. Consider the following random experiment. A doctor is interested in determining whether or not his patients think that he listens attentively to what they are saying. He randomly selects several patients and administers an anonymous survey that asks which of the following categories best describes his attentiveness: Very Attentive, Somewhat Attentive, Not Attentive.
    a. Determine the sample space for the above experiment.
    b. Determine all possible outcomes for the event $A = \{$the doctor is not described as Very Attentive$\}$.

13. A gambler has made a weighted die. In order to decide which of the six sides is most likely to turn up, he tosses the die 33 times and notes the number of dots on the uppermost surface. The results of the experiment (sorted) add space are shown in the following table.

Rolls of a Weighted Die										
1	1	1	1	1	1	1	1	1	1	1
1	1	1	2	2	2	2	2	2	2	3
3	3	3	3	4	4	5	5	5	6	6

    a. Using the relative frequency approach, what is the probability of observing each side?
    b. Assuming all outcomes have an equal payoff, which side do you think the gambler will bet on when the die is tossed?
    c. Were your conclusions regarding the probability of each outcome of the roll of the die obtained empirically or deductively?

14. Assume there are two red, two yellow, and two blue buttons in a hat. A button is randomly drawn out of the hat, the color is noted, and the button is returned. This is repeated fifty times. The results are listed in the following table.

Button Drawing				
Yellow	Yellow	Red	Yellow	Red
Red	Red	Blue	Red	Blue
Blue	Red	Red	Yellow	Red
Red	Blue	Yellow	Red	Yellow
Yellow	Blue	Red	Blue	Red
Red	Red	Red	Red	Yellow
Blue	Yellow	Yellow	Blue	Red
Yellow	Red	Red	Red	Yellow
Red	Yellow	Yellow	Yellow	Red
Red	Red	Blue	Red	Blue

a. Using the relative frequency approach, what is the probability of drawing each color?

b. Were the probabilities in part **a.** determined deductively or inductively?

15. Twenty-five small business owners in an urban area are randomly selected and asked if they own a handgun. Twenty-two of those surveyed said that they do own a handgun. If a small business owner is randomly selected from the sample, estimate the probability that the person will own a handgun.

16. Thirty high school teachers are randomly selected and asked if they favor standardized testing. Twenty of those surveyed said that they did favor standardized testing. If a high school teacher is randomly selected from the sample, estimate the probability that the teacher will favor standardized testing.

17. Fifty chief executive officers (CEOs) of publicly traded companies are randomly selected and their salaries are determined. Forty-five of the CEOs selected have salaries in excess of $500,000. If a CEO from one of the selected publicly traded companies is randomly selected from the sample, find the probability that the CEO will have a salary in excess of $500,000.

18. Forty emergency calls to which a local police department responded were randomly selected. Of the forty emergency calls fifteen were categorized as burglaries.

a. Estimate the probability that the next emergency call to which the local police department responds will be a burglary.

b. Which probability interpretation are you using in this problem?

19. For the following situations, decide which probability interpretation is most reasonable to use: relative frequency, subjective, or classical.

a. Whether or not you will have a wreck on your next trip to the mall.

b. Whether or not a car coming off the Ford assembly line will have a defect.

c. The probability that you will graduate from college in four calendar years.

d. Whether a person will be in an automobile accident during the next year.

e. The probability that you will be dealt a full house from a well-shuffled deck of cards.

20. For the following situations, decide which probability interpretation is most reasonable to use: relative frequency, subjective, or classical.

a. Suppose you have purchased a lottery ticket. Describe your chances of winning the lottery.

b. The probability you will enjoy a vacation trip to Mexico.

c. The probability your company's sales will exceed seven million dollars this year.

d. One hundred people receive keys to a new car in a radio contest. Only one key actually fits the car. The probability that key number 25 will open the car door.

e. The probability that you will get a ticket if you drive 70 mph on the interstate between work and home this coming Tuesday.

f. The probability that the S&P 500 will increase or decrease by at least 25 points in one day.

21. Consider a student who is taking a multiple choice examination where there are five possible answers for each question. Since the student has not studied or attended any of the classes, the student decides to randomly guess at each question.

a. Find the probability that the student will answer the first question correctly.

b. Find the probability that the student will answer the first question incorrectly.

22. A game show contestant has to choose one of three doors to win a prize. Behind one door the prize is a trip to Hawaii; behind another door, the prize is a large flatscreen TV; behind the final door, the prize is a bag of potatoes. If a contestant randomly selects a door,

a. Find the probability that the contestant will win a trip to Hawaii.

b. Find the probability that the contestant will not win a trip to Hawaii.

c. Which probability interpretation are you using in this problem?

23. For marketing purposes, an online pet supplies company classifies its customers by state of residence and whether or not they own a pet. The research department has gathered data from a random sample of 682 customers. The data is summarized in the table.

a. What is the probability that a customer lives in Florida?

b. What is the probability that a customer owns a pet?

c. Which probability interpretation are you using in this problem?

State of Residence and Pet Ownership of Customers

State	Owns a Pet	Does Not Own a Pet
Arizona	66	42
Colorado	57	70
Florida	143	118
South Carolina	125	61