Computing Research Project

Scientific Method

Scientific method

- The scientific method is an approach to acquiring knowledge
- Scientists seek answers to the questions they devise.
- Is a carefully developed system for asking and answering questions so that the answers we discover are as accurate as possible

Scientific method definition

The scientific method is a method of acquiring knowledge that uses observations to develop a hypothesis, then uses the hypothesis to make logical predictions that can be empirically tested by making additional, systematic observations. Typically, the new observations lead to a new hypothesis, and the cycle continues.

Step 1: Observe Behavior or Other Phenomena

- Often begins with casual or informal observations.
- Based on your observations, you begin to wonder why people do not
  - Example: it is true that the better students tend to sit in the front of the class?
- At this stage in the process, people commonly tend to generalize beyond the actual observations
- In simple terms, inductive reasoning involves reaching a general conclusion based on a few specific examples

Example of observation

- For example, suppose that you taste a green apple and discover that it is sour. A second green apple is also sour, and so is the third. Soon, you reach the general conclusion that all green apples are sour
- At this point you could go to the library (either in person or on the Internet) to discover what other people have already learned about green apples and it’s taste

The following scenario combines observation and induction to demonstrate how the first stage of the scientific method can actually work. Suppose it is the third straight day of dark, cold, and dreary weather in late October, and you notice that you are feeling a bit depressed. It is not a serious clinical depression; you simply have realized that the carefree days of summer are definitely over and you are now facing several long months of cold and overcast winter days. As you mope through the day, you begin to wonder if others are sharing your feelings, and so you start watching your friends and colleagues. Soon, you reach the general conclusion that people seem to become sadder and more depressed during the winter than in the summer. At this point you could go to the library (either in person or on the Internet) to discover what other people have already learned about winter and depression. In most cases, you will find extensive information including theories, opinions, and actual research studies. The existing knowledge (method of authority) may provide an answer for your question and usually will give you a much better understanding of the issue. However, if you still have questions and are at all curious about the phenomenon, you are ready for the next step in the scientific method.

Step 2: Form a Tentative Answer or Explanation (a Hypothesis)

- This step in the process usually begins by identifying other factors, or variables
- For example, what other variables are associated with winter and depression?
- You can identify variables based on common sense, or your background research in the library or on the Internet.

Step 2(continue)

- The observed relationship between winter and depression might be associated with variables such as the weather and health
- A quick library search reveals that atmospheric conditions, seasonal variations, and health are all variables that have been studied in relation to depression.

Step 2(continue)

- Notice that we now have at least two possible explanations for the observation that people tend to be more depressed in the winter than in the summer:
  - Health: People tend to catch colds and get the flu during the winter, and perhaps their illness leads to depression.
  - Weather: Perhaps people become depressed in the winter because the weather is literally dark and depressing.
- Next, you must select one of the explanations to be evaluated in a scientific research study
- At this point, you have a hypothesis

Step 3: Use Your Hypothesis to Generate a Testable Prediction

- Usually, this step involves taking the hypothesis and applying it to a specific, observable, real-world situation

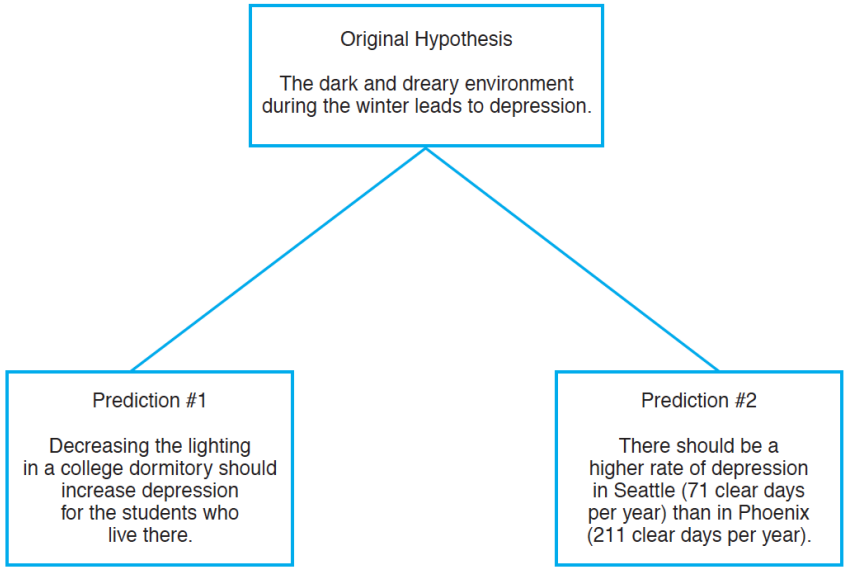

FIGURE 1.2 Two Testable Predictions Derived from a General Hypothesis

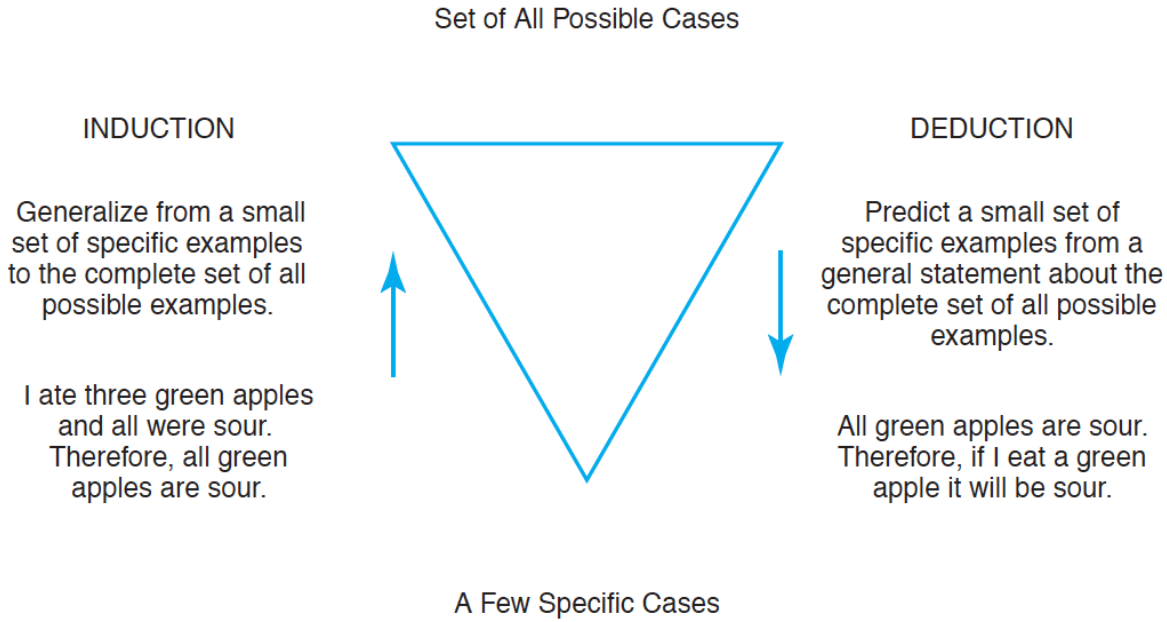

FIGURE 1.3 Examples of Induction and Deduction

Inductive reasoning uses a few limited observations to generate a general hypothesis. Deductive reasoning uses a general hypothesis or premise to generate a prediction about specific observations.

Step 4: Evaluate the Prediction by Making Systematic, Planned Observations

- This is the actual research or data collection phase of the scientific method
- The goal is to provide a fair and unbiased test of the research hypothesis by observing whether the prediction is correct.
- The researcher must be careful to observe and record exactly what happens, free of any subjective interpretation or personal expectations

Step 4: example

A researcher could place 100-watt light bulbs in all of the lamps on one floor of a college dorm and use only 60-watt bulbs on another floor. After 6 weeks, all of the students are tested for depression and the two groups of scores are compared to determine whether there is a relationship between depression and the amount of light in the environment. Notice that the research study is an empirical test of the research hypothesis

Step 5: Use the Observations to Support, Refute, or Refine the Original Hypothesis

- The final step of the scientific method is to compare the actual observations with the predictions that were made from the hypothesis
- To what extent do the observations agree with the predictions?
- Lack of agreement indicates that the original hypothesis was wrong or that the hypothesis was used incorrectly, producing faulty predictions
  - In either case, notice that you have circled back to Step 2

Our researcher found lower depression scores for the students on the brightly lit dormitory floor than for those on the dimly lit floor. This result provides support for the original hypothesis and indicates that lighting is a factor to be considered in explaining winter depression. Suppose, however, that the results also show that some students with bright lights are still depressed and some students with dim lights show no signs of depression. This result indicates that lighting is not the entire answer.

If the results show no difference between the two groups of students, then we must either conclude that lighting does not affect depression or that the difference in lighting was not big enough or did not last long enough to affect the students. In either case, other factors must be considered and other hypotheses must be tested before we can completely explain winter depression

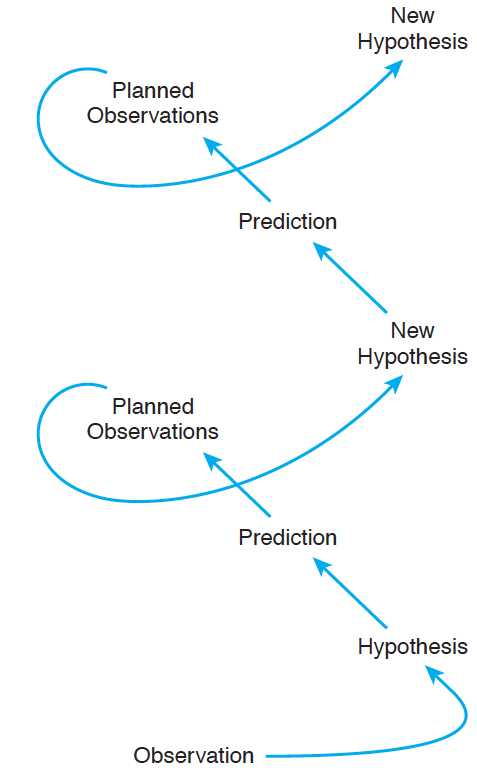

FIGURE **1.4** The Process of Scientific Inquiry

The scientific method can be viewed as a circular process or a spiral of steps. Initial observations lead to a hypothesis and a prediction, which leads to more observations and then to a new hypothesis. This never-ending process of using empirical tests (observations) to build and refine our current knowledge (hypothesis) is the basis of the scientific method.

Three important principles of the scientific method

- Science Is Empirical
  - We mean that answers are obtained by making observations.
- Science Is Public
  - We mean that the scientific method makes observations available for evaluation by others, especially other scientists.
- Science Is Objective
  - The observations are structured so that the researcher's biases and beliefs do not influence the outcome of the study

Group discussion

LEARNING CHECKS

Describe what it means to say that science is empirical, public, and objective, and explain why each of these principles is important.

Describe the differences between science and pseudoscience.