Bingo cages aid accounting research

by Shyam Sunder

Recent visitors to the accounting department may have been surprised to find bingo cages, dice, and other questionable devices in some professors' offices. Puzzled but polite, they averted their glances to spare their teachers embarrassment. Could it be true? Do accounting professors really play with bingo cages?

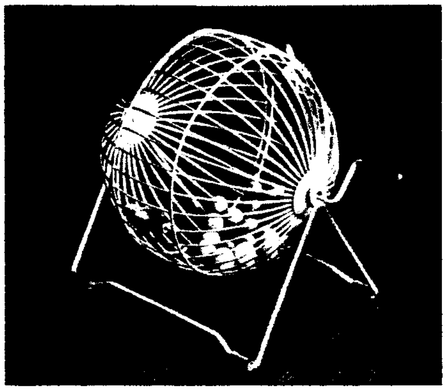
Indeed it's true—and they're involving students too! What is going on?

Accounting provides information; information is of value only in a world of uncertainty. Thus, conducting empirical research on the value of information under uncertainty requires random numbers. A bingo cage happens to be an excellent device for generating random numbers.

A random number is based on chance. It can take any one of two, three, or more values. Before the chance event occurs nobody can tell what the random number will be. If you assign one for heads and zero for tails in a coin toss, then tossing a coin yields a random number that can be either one or zero. The number of cars that pass in front of my house in the next hour is also a random number that could be as small as zero and perhaps as large as 1,000.

We are immersed in a sea of random numbers. The number of seconds it takes to brush my teeth, the number of pieces of mail I receive, the number of calories I take in at lunch, the number of students who attend my class, and the precise time I fall asleep are all random numbers. Given this generous supply of random numbers, why would anyone need special devices for generating them?

Researchers need such special devices for generating random numbers for precisely the same reason that gambling houses do. Therefore, random numbers must have known and stable characteristics. While random numbers are ubiquitous in our daily life, their properties are mostly unknown and often changing. To examine the effect of uncertainty on human and organizational behavior, researchers need random numbers with known and stable properties for the same reason a surveyor needs a measuring tape with unchanging and known length and markings.



Coins, dice, cards, and bingo cages are some of the better known devices for generating random numbers. Most statistics books also carry tables of certain types of random numbers. Finally, there are some computer programs that generate various kinds of numbers. Since a computer is much more convenient and flexible than a bingo cage, why should anyone bother with the latter?

When conducting experiments that involve gaming among human players, coin tosses, dice, cards, bingo cages, and other such *physical* devices are still superior to computers for two subtle but important reasons. The first of these reasons has to do with the nature of random numbers and the second concerns the role of information in the games people play. A random number depends on a chance event. Whether something is or is not a chance event for a person depends on how much that person knows. What I find under the Christmas tree may be a chance event to me until I open my present, but it is not for my daughter who spent hours shopping for it. A number in the random number table is random only until one reads it; and then, relative to the knowledge of the reader, that number ceases to be random.

Computers, in spite of all their sophistication, generate random numbers through a well-specified series of operations. The result is a fixed, cyclical—albeit long—sequence of numbers. For those unfamiliar with the workings of computers, the numbers a computer produces are, both in fact and appearance, random numbers. However, for someone who knows the system, there is nothing random about the sequence generated by a computer: each number follows and is followed by others in a known order. Computer scientists have appropriately dubbed such numbers "pseudo-random" numbers.

Random numbers generated from physical devices are fundamentally different from those generated by computers. Nobody knows which ball in a bingo cage has more or less chance than others of being drawn. While it is conceivable that one may be able to use the laws of motion to predict which ball might be drawn next, nobody has apparently succeeded in making reliable predictions of this type. Until someone acquires such ability, the bingo cage remains a generator of "true" random variables. It is the acquisition of such an ability in the card game of Black Jack by the so-called "counters" that led some casinos to change the rules of that game.

The pseudo-random nature of computer-generated numbers is, however, only part of the reason why researchers in accounting and some other disciplines tend not to employ them in experimental work with human subjects. The rest of the explanation lies in the subtle interplay of information in games among human beings.

Human behavior in which the action of each person affects the welfare of the others is characterized as a game. In a game, the action strategy of a person depends not only on what she knows but also on what she knows about what others know, and on what she knows about what others know about what she knows and so on. The technical concept of "common knowledge" in game theory refers to that which (1) everyone knows, and (2) everyone knows that everyone knows, and (3) everyone knows that everyone knows that everyone knows, and (4) everyone... *ad infinitum*.

In conducting controlled experiments on human behavior in game settings, it is important that the experiment is conducted in such a manner that the information that is supposed to be common knowledge is indeed common knowledge. For example, suppose I distribute slips of paper, each marked with an X, to everyone in a room. Everyone in the room knows X but everyone does not know that everyone knows X. Therefore X is not common knowledge in the technical sense we defined above, even though each individual in the room knows it. One way of making X common knowledge would be to write it on the chalkboard.

Whether something is or is not common knowledge is not a mere academic quibble. It turns out that people behave radically differently when the same information is privately known to all individuals and when it is common knowledge. This is the very essence of the old story about the boy who cried that the emperor had no clothes.

jects happen to be familiar with the workings of computers, it may be even more difficult to convince them of the randomness of numbers presented.

The beauty of the bingo cage and other such physical devices is that their workings can be easily understood and verified by the subjects. It is actually possible to make the nature of the numbers generated by such devices common knowledge. It is almost impossible to achieve this with computers. High technology is beat by its own sophistication.

Okay, so researchers use bingo cages to generate random numbers that are not only "pure" but whose "purity" is common knowledge. What kind of accounting research needs these random numbers?

Accounting is widely thought to be a key link between firms and the markets in which their securities are traded. Many of the statutory requirements of accounting disclosure under the Securities Act of 1933 and the Securities and Exchange Act of 1934 are based on assumptions about how such disclosure affects the behavior of markets and the distribution of wealth among traders. The insider trading charges filed by the Securities and Exchange Commission against Mr. Dennis Levine in May 1986 have spurred fresh debate on the possible consequences of insider trading. The effect of such activities on Levine's wealth appears clear enough; their effect on the overall efficiency of the stock market is less clear.

Gathering empirical data on such insider trading is difficult, if not impossible, because of the legal implications of such activity. Recent years have seen the development of theories of insider trading that remain largely untested due to this problem. Conducting laboratory tests with human subjects who trade in a miniature market with real money and information is one possible way of researching questions about insider trading. This is one of the purposes for which accounting faculty use bingo cage-generated random numbers.

The idea of common knowledge itself also plays a direct and important role in corporate financial reporting and financial markets. The public disclosure laws for publicly held firms require not mere disclosure but *public* disclosure. For certain functions of financial reporting and security markets it is not enough that everyone knows that information, but that everyone knows that everyone knows the information. If this latter condition is not satisfied, it may lead to bluffing and a waste of society's resources. We can seek an understanding of the public disclosure laws in terms of the properties of common knowledge of information. ■

Shyam Sunder is the Honeywell Professor of Accounting at the University of Minnesota School of Management.

ACCOUNTING RESEARCH CENTER

In conducting laboratory experiments with human subjects and random numbers, it is often insufficient for the researcher to use numbers that are in fact random to the researcher. The researcher must also convince the human subjects so they *believe* the numbers are random. In other words, it becomes important for the randomness of the numbers to be common knowledge between the experimenter and the subject. This is where the computer-generated random numbers fail to measure up.

In order to make the randomness of the numbers given to the subjects common knowledge, it is necessary that both the subjects and the researcher understand the procedures used to generate the numbers. When the pseudo-random nature of the computer-generated numbers is explained, it may occur to the subjects that the numbers, which are random to them, may not be random to the researcher at all. If the subjects are not familiar with the workings of the computer, how could the researcher convince them that the numbers appearing on the monitor were not fixed by the researcher? Frankly, if the sub-

Expert from page 5

more successfully than either could do it alone, he says. With help from a computer, an expert can achieve a level of proficiency that wouldn't have been possible before.

In any case, not all of expertise can be understood by scientists or translated into a computer program. "There's a lot of left over," Johnson says. "The kinds of expertise that lend themselves to [computer] modeling are those that do not rely on a lot of visual or other perceptual processing or on qualitative judgments."

Cognitive scientists can program a computer to make the kind of leap that comes from having a strong knowledge base. "But if you're talking about the creative leap, the one you've never taken before, that we have a lot of trouble with."

Just as experts don't need to worry about being replaced by computers, neither do the rest of us. Interestingly, Johnson says, the hardest problem for cognitive scientists is trying to teach a computer common sense.

"Give me an expert any day," he says. "I'm much more likely to be successful in capturing the thinking of an expert than some aspect of our daily life. That's a humbling observation. Something like common sense is beyond our reach."

This article originally appeared in the March 1986 edition of UPDATE, *a publication for University of Minnesota faculty and staff published by University Relations.* ■