POME

PHILOSOPHY OF MATHEMATICS EDUCATION JOURNAL 11 (1999)

CHANCE AND CHOICE

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It's quite difficult to think of something that computers *can't* do with numbers, but there is one thing: computers can't produce a genuine 'random number,' like the ones you get by tossing coins or throwing dice. For games and suchlike, where the program has to simulate throwing a dice or dealing out cards, they have subroutines which produce 'pseudo-random numbers,' and the programmers hope you won't be able to distinguish them from really random numbers.

I know two ways of programming for pseudo-random numbers - I dare say there are others.

One is to use the computer clock. Most computers have a subroutine in the operating system which does nothing but count up from one to some very large number (perhaps 65,536, 2 to the 16th, in a small computer, or 2 to the 32th, more than four billion, in a bigger one) and then start again at the beginning, over and over again. This counter goes very fast indeed, it runs right through its range of numbers in minutes or even seconds. It's used to work the clock routine in the operating system, because the counting goes at an absolutely constant rate. But you can also read it at any instant for a pseudo-random number. If the counter number is odd you call it 'heads,' if it's even you call it 'tails,' or something like that.

This works pretty well for some purposes. But suppose someone writes a program with a loop in it which reads the clock for a random number each time the loop turns - you might do this 52 times to simulate shuffling a pack of cards. The program loop will also run at an absolutely constant rate, so the numbers it reads will come out in a regular sequence. In the worst case it might actually read the same number each time! Not so random.

The other method uses a 'seed formula': you feed a 'seed' number into a subroutine which turns it into a different number by a formula designed to make it as unlike the seed as possible (eg multiply the seed by a large number, divide the result by a different large number and use the remainder from the division). The seed can either be got from the clock or can be the result from the last use of the seed formula; or the program may ask the operator for his choice of seed. Again this works quite well. But if you use the seed formula over and over again, after the computer has used up all the numbers up to the limit it can handle, in an apparently random sequence, it will go through them all again in exactly the same sequence.

You see the problem. Random numbers are supposed *a*) to be unpredictable and *b*) not to show any regularity or pattern. (These amount to the same thing, really. The only way you can predict anything - unless you have supernatural powers! - is by expecting that it will follow some pattern you have been able to observe.) But computers, at least in theory, are entirely predictable machines. The designer of the computer, or anyone who understands how it works, *in theory* could predict the result of any operation the computer performs. And because the computer is a finite machine - there's a limit to the size of the numbers it can handle - repeating *any* operation indefinitely will produce a repeated pattern eventually, though it may be a very large-scale one.

When you come to think of it, the case isn't much better with coin tossing or dice throwing. *In theory*, if you knew very precisely the forces acting on the dice or coin, their weight, moment of inertia, distance from the ground, etc, you could predict which way up the coin or dice will fall, or even that it will land balanced on its edge or corner. So even dice and coins can only produce pseudo-random numbers. They only seem random because *in practice* one never does know all those things.

It seems that the computer's pseudo-random numbers, if you program with discretion, can be just as random (or anyway nearly as random) as the numbers you get by throwing a dice. In theory you could predict them but the computer produces them much faster than your predictions.

In a completely determined universe there's no such thing as chance - *in theory*. All there is is pseudo-chance, produced by the fact that *in practice* there are many things we don't know about which will cause certain events to happen in ways we can't therefore predict. Why did the lightning kill Smith but not Brown? We don't know (God knows, we say); it was pure chance. It wasn't really, it was pseudo-chance. Pseudo-chance is what produces *effects that are too difficult for us to predict*.

According to the quantum physicists, we don't live in a completely determined universe, there are some events in the world of subatomic particles which really do happen by chance, not by pseudo-chance. It's not that we don't understand why they happen, not even that there's no way we could find out. They happen for *no reason*, there's nothing there to understand.

Einstein strongly resisted this notion - 'God does not play dice with the universe,' he said - but it's now orthodox, the accepted theory. I think I agree with Einstein. (Bertrand Russell did too - and unfortunately so did the orthodox Marxist/Leninist physicists of the old USSR, for very bad reasons.)

Until quantum physics was invented there actually was no such thing as 'pure chance,' or to put it another way 'chance' simply meant 'effects which are too hard to predict' - what I'm now calling pseudo-chance. 'Pure chance' is a *new* concept, a hypothetical concept of quantum physics, and I'm very suspicious of it. The physicists seem to be saying 'we don't know why these things happen and we're not going to try to find out.' This is not what we pay scientists for.

I believe there are now 'random number generator' machines (not ordinary computers) which use 'radioactive decay' to generate their numbers, so that they actually are the result of the quantum physicists' 'pure chance.' I don't think anyone believes that the fall of a dice is controlled by quantum effects, so dice still make pseudo-random numbers. Perhaps you could make very teeny dice which would give real random numbers by quantum effects, but it's hardly worth the trouble.

There's a parallel here with the age-old controversy about 'free will' and 'determinism' (or 'predestination' in the older theological terms). If the universe is wholly deterministic, then *in theory* we can never make a free choice about anything; all our choices are automatic, controlled by the way the atoms fall about inside our brains or by the hidden motivations in our subconscious mind. (If we saw something nasty in the woodshed when we were three, we may end up unable to eat fish, or homosexual, or something.)

By analogy with the idea of pseudo-chance, it seems obvious that even in a determined universe we have 'pseudo-free will.' However well you know a person, *in practice* you can't always predict what choices they are going to make. I've been married for forty-five years, and my wife and I have never been separated for more than maybe four weeks at a time, when I was travelling on business. I suppose I know her about as well as anyone ever knows anyone else. But I never have the faintest idea what she's going to say next, and when we go out for a pub lunch, if you asked me to predict what she will choose from the menu I would be wrong as often as not. If (pseudo-)chance means unpredictable events, then I maintain that (pseudo-) free will means unpredictable decisions.

This isn't quite satisfactory. Mostly we feel that our choices are actually more free even than that. It's been suggested that in some unfathomable way our choices may even depend on quantum effects inside our brains, so that they're unpredictable in theory as well as in practice. I'm not sure that that makes it any better.

The traditional cop-out is to maintain that our (free) will is a function of our soul (or mind, or personality), which isn't material - it's 'spiritual' - so it isn't subject to the deterministic laws of physics and chemistry at all. Descartes, the seventeenth-century mathematician and philosopher, proposed that there are two worlds, the material world and the spiritual, but in some unfathomable way our minds, which are spiritual, are linked with our material brains and are able to control them.

This was always a mystery and caused a good deal of controversy. It was rather thoroughly debunked in the 1950s by Professor Gilbert Ryle (*The Concept of Mind*), whom I remember as one of our more entertaining lecturers when I was 'doing' Philosophy at Oxford. He called it the theory of 'the ghost in the machine.'

I'm quite sure Gilbert Ryle wasn't familiar with computers and computer programs - hardly anybody was in the 1950s. If he had been he mightn't have been quite so scornful about ghosts in machines. I have a program on my computer which plays quite a good game of backgammon; backgammon is a game partly of chance (you must throw a pair of dice on each move) but partly also of skill, because what you do with your throw of the dice is a matter of strategy and tactics. Bridge and even poker are similar mixtures of chance and choice. Draughts and chess aren't, they're *all* skill.

It isn't the computer that plays backgammon, it's the program. If you haven't got the program loaded in your hard disk the computer knows nothing of backgammon at all. And the program is *not in the material world*. If you wanted to be fanciful you could call it a 'spirit,' or even a 'ghost in the machine.' When you copy the program into the computer from a floppy or a CD, the computer doesn't get any heavier; when the program was written onto the floppy or CD in the first place that didn't get any heavier either. A program is like a story or a tune - or a number, for that matter. It exists, in some sense, but not in any particular time or place, it doesn't take up any (physical) space and it doesn't weigh anything. Of course, the disks are material and the 'program is on the disk,' but this isn't the program, it's a *recording* of the program. If you damage the tape of a Schubert quartet you don't damage the quartet, only the tape.

Programs even have a kind of personality, though a very limited one. The backgammon program makes strategic and tactical decisions depending on the throw of the dice. When its evaluations indicate two possible moves with equal chances, it chooses one - at random? - it seems to play with a certain characteristic style, however. Other programs, even utilitarian ones like word-processor programs, also have this kind of personality, of course reflecting the personality of the programmer who wrote them.

I don't know the details of the backgammon program, but without doubt it uses the computer's pseudo-random number subroutine, both to present the throws of the dice and to choose between possible moves after it's evaluated them for strategic and tactical advantage. So its dice throws are pseudo-random and its choices are made with pseudo-free will. But the effect is very convincing. I think it passes the Turing test (if you can't guess whether it's a person thinking or a machine, then the machine is thinking) - but only of course as a backgammon player.

It's tempting to say 'the brain is a computer and the mind is its program.' Very tempting indeed, but dangerous. I prefer to say 'the relation between mind and brain is rather like the relation between a computer program and a computer.' For one thing, the brain and the mind inhabiting it are completely inseparable. You can't stick a plug in your ear and load a new personality from disk - or even a knowledge of Sanskrit, or the contents of today's newspaper. Nice if you could. You can't even erase any programs, or parts of them, from your brain. We haven't the technology to do such things, but I very seriously doubt that there *could be* any technology to do it.

Computers are (usually) built with completely blank minds. Then the manufacturers load them with an 'operating system,' which is a program, but it won't really do anything but accept other programs. Then the owner of the computer can write his own programs, or more often load programs from disk, to do all the things he wants the computer to do. When he's done whatever he wants the program to do he can erase the program from the computer - he's still got it on disk for the next time. Brains can't do anything like that at all.

But brains are different from computers, and minds from programs, in other ways. Computers feel no hope, fear, love, or any other emotion. They have no imagination or ideas of their own. They can't laugh, dream, or make up stories, tunes, jokes or even original computer programs; they can't even chat like a reasonable person. Programs have been written to simulate some of these activities, but they're all more or less pathetic, like a child dressing up in grown-up clothes. If minds have all these faculties that programs lack, perhaps they have real free will as well, not just the pseudo-free will which is derived from random number generators. How could one possibly tell?

My only point is that if the mind is like a computer program - and I believe it is, up to a point - then it is, after all, an immaterial, 'spiritual,' entity and isn't subject to physical laws. So it might be genuinely 'free' even in a completely determined world. The program runs the computer, not the other way round. Perhaps the mind really does control the brain, in a way Descartes couldn't possibly have imagined.

I say nothing about immortality; I don't know whether our souls are immortal or not. If you destroy a computer, you destroy any programs stored in it, and if there are no copies on disk that's the end of them, there's no way to recover them. Perhaps our minds are different.