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The More Things Change, The More They Stay The Same

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In 1994, when I was a member of the Computer Science Section Council, I wrote a column for the section newsletter titled What's the Good Word? My column was published for just one year, and the section later changed its name to Technology. However, the editor of this newsletter recently came across one of these old columns and asked me to update it. The original can be found on page 10 of the September 1994 issue [*http://www.soa.org/library/newsletters/compact/1994/september/csn9409.pdf*].

The first paragraph of that article set the scene:

The word "emergent" means, among other things, something that arises unexpectedly. A classic example is the mixture of nitric and hydrochloric acid, known as aqua regia (royal water), which dissolves gold or platinum. Neither acid alone has any effect on these metals. More generally, an "emergent" result, in this sense, is something that could not have been predicted from any of the individual items that brought it about.

Another example of an emergent property is fire. The ancients actually considered that fire was one of the four elements of which everything is made. When something burned, they interpreted this as the fire element being released from the thing that burned. Today we understand that the process of combustion releases heat when oxygen combines with fuel. The hot gases rise, giving off not only infrared radiation, but also radiation in the form of visible light. As the gases rise and expand, they cool and the visible radiation is no longer produced. Neither the fuel nor the oxygen gives off visible light before combustion begins. It is the process that produces the emergent effect, which we call flames.

I have sometimes thought that consciousness is analogous to this. There is a process that produces an unexpected effect that could not be predicted from any of the physical and chemical elements that make a human being. Can this same emergent property be generated by a computer program? This is one of the challenges for the science of artificial intelligence (AI). Does your computer have a mind of its own? There are days when I am sure mine does, particularly when it becomes necessary to restart my machine yet again.

But actually, research in AI seems to be progressing very slowly. Several exciting developments in the 1970s suggested that we were near a break-through in natural language communication with our machines. It doesn't seem to have happened yet. The aim of the AI developers is to produce software that could pass the Turing Test which basically asks whether a computer could interact with us in a way that makes it impossible to tell whether it is actually a person. To keep us from being distracted by appearances, the test is supposed to be carried out using some electronic device. So far, though, silicon-based sentient beings are only found in science fiction.

Another search for sentience targets outer space. The Search for Extra-Terrestrial Intelligence (SETI) is making use of idle computers connected to the Internet. I know that some actuaries have made their computers available for this project, in which data from radio telescopes is downloaded and analyzed for the presence of signals. The analytical software runs when nobody is using the machine, searching for anomalies in all the data collected by radio telescopes all over the world. If there is intelligence out there, perhaps computers will help us find it.

Meanwhile, the need to protect Web sites against computer attacks has generated a test called CAPTCHA. This is a program that displays a series of letters and/or numbers in various fonts and positions. So far, computers have proved to be very bad at character recognition, while humans can easily interpret the series and type in what they have read. The acronym, in case you were wondering, stands for Completely Automated Public Turing Test To Tell Computers and Humans Apart.

Going in a different direction, one of the variations on Moore's law indicates that on average, computing power per unit cost doubles approximately every two years. (The original version of the law referred to the number of transistors per integrated circuit.) This is seen as each year, more powerful computers become available for lower prices than the previous year. The trend in hardware is mirrored by the software side, where more elaborate operating systems and application programs make use of those more powerful computers. This sometimes leaves users annoyed at having to learn new alternatives to the old shortcuts that made them more productive.

Also, these bigger, faster, more powerful tools enable actuaries to build more complex models. Over the

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past few decades, there has also been a trend toward more and more use of stochastic models. This began with variable annuities, particularly those with embedded guarantees. This was merely hinted at in my prior article.

The recently adopted VA CARVM rules for U.S. statutory reserves, as well as those for associated Risk Based Capital (RBC), use stochastic models to establish the amounts required to handle worst case scenarios using a metric called Conditional Tail Expectation (CTE). Explaining CTE is beyond the scope of this article, however.

For some applications, such as Economic Capital, blocks of business are projected using stochastic models. For each cell of the stochastic projection, it becomes necessary to calculate the statutory reserves and RBC. This results in what might be called S2, or stochastic on stochastic. This stresses existing computer power. Solutions include the use of simplified models for either the product or the economic scenarios; or the use of multiple computers in a configuration sometimes referred to as grid computing.

Next in line for applying stochastic tools: Life insurance and non-variable annuities, then health products, including long term care. Our lives as actuaries continue to become more interesting all the time. In an article that gave a new tool for analysis of problems in the field of demographics, the author commented something like, "As we give sharper knives to students, the exam committees serve up tougher steaks." I think this kind of thing still happens to us, even after we get through the exams.

In the previous essay, I talked about the idea of a personal computer on each employee's desk, and linking them together in a local area network (LAN). I didn't mention the Internet, but in many ways, it just seems like a super-LAN. Actually, the first contact I had with the World Wide Web surprised me by how text-oriented it all was. Even now, although You-Tube is ubiquitous, and you can get maps and satellite photos of almost anywhere in the world, most of the material on the Internet is still text-based. It's also still rather linear, although it is possible to follow hypertext links until you come full circle back to where you began.

It's not **all** text-based, though. One of the newer trends is actually running your application software on the Internet. It's called Software as a Service and has also been referred to as cloud computing. As InfoWorld puts it, "The next big trend sounds nebulous, but it's not so fuzzy when you view the value proposition from the perspective of IT professionals." More generally, software to develop new applications comes under the cloud heading, as well as various computer-based business services, like payroll processing.

Going back to Moore's law, there are some who suspect we may be getting to the theoretical limits of squeezing more and more logic units into a given space. Perhaps it is time for a paradigm shift, this time from a computer hardware perspective. One possibility being seriously explored is the use of quantum mechanics in building our computers. In traditional computers, the binary digit, or bit, has only two possible values—1 or 0. These can be mapped into true or false or they can be combined to make numbers as large as we might care to work with.

Quantum computers, however, have q-bits. Their value is, in true quantum fashion, indeterminate. The user can impose a probability function on each bit. Thus, one can think of each bit as having a value somewhere on the interval (0,1). Properly programmed, such a computer—if one existed—could solve problems that are currently beyond the abilities of traditional computers, because testing all the possibilities would take too long.

An example, mentioned in my previous article, is the factorization of a very large number into two primes, each of which is quite large as well. The difficulty of doing this factorization is the basis of many encryption systems, and having an easy way to break the code could be a huge problem—except that a new encryption system could be implemented, using other features of quantum mechanics. That may not be an example of an emergent property, but it certainly is a pleasant surprise.

I close this essay, dear reader, with a wish that all of your surprises will be pleasant ones. ■