

DNA to the aid of e-commerce

Nature's script for genetic information could be a way to keep things secret

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An important part of commercial transactions is to control who can read a message, and then to assure the reader that the message is genuine. For centuries, the device to do this was the sealed envelope and the sender's signature. With transactions over the Internet, however, there is a need for a different way to seal the message. And then to know that it has not been tampered with.

Cryptography, or the science of coding, was first of interest in the military and the world of espionage, and many ingenious methods have been devised. Not all of those, however, are useful in electronic communication of the rising numbers of banking transactions. The methods used there are automated coding, and they depend, largely, on a secret number, of many digits, which the sender and the receiver use to code and decode a message.

The core of secure transactions thus reduces to generating sufficiently complex numbers, that is to say, numbers that are difficult to guess, and to create them speedily and easily. This, however, can be a challenging thing to do, and several schemes, including those that use the quantum effects in lasers, have been developed. In a paper in the journal, *Nature Communications*, Linda C Meiser, Julian Koch, Philipp L Antkowiak, Wendelin J Stark, Reinhard Heckel and Robert N Grass, from the Swiss Federal Institute of Technology, Zurich, and the Technical University of Munich, describe a method based on the ways the DNA molecule assembles itself, which turns out to be effective indeed.

The relevant data, or the payload, of an electronic transaction is usually the identity of a paying and a receiving account and then the amount of transfer. Else, it could be the text of a contract, or the offer or acceptance, on the way to closing a contract. We can see that all of commerce hinges on assuring the secrecy and the integrity of such messages.

Electronic transmission of data is in the form of binary numbers, which consist of a series of "0"s and "1"s. For instance, the sentence, "Thirty days hath September" reads like this in binary, "01010100 01101000 01101001 01110010 01110100 01111001 00100000 01100100 01100001 01111001 01110011 00100000 01101000 01100001 01110100 01101000 00100000 01010011 01100101 01110000 01110100 01100101 01101101 01100010 01100101 01110010", with each group of eight numbers standing for an alphabet. Now, if this collection of "0"s and "1"s were jumbled up, the groups of eight numbers would stand for different letters, even numbers and punctuation marks – and the message could be unrecognisable.

This kind of jumbling can be done in a



complex way, by special, mathematical methods, which would make it impossible to unjumble. In e-commerce, the way the letters have been jumbled, and hence the way they need to be brought back, is based on a long, secret number, which only the sender and the receiver know. The message, hence, cannot be opened by anybody but the proper recipient and when the message opens, the receiver would know it came from a specific sender. As any change in the jumbled message would make it impossible to open, the receiver would also know that the message has not been tampered with.

This number that is the basis of the jumbling needs to be very complicated, in fact, a "random number", that is to say, without the digits following a pattern that could be guessed or worked out. Methods like throwing a dice, or the last digit of the number of grains in a handful of sand do generate a highly unpredictable series. Those, however, are time consuming and cannot be used for transactions where random numbers are required on the fly!

There are hence methods that use a complex, mathematical procedure, to generate an "almost random" number, given a starting input. A limitation of this method is that the procedure generates the same random number every time it gets the same starting input. One example of the input is the time, in milliseconds, when a computer is switched on.

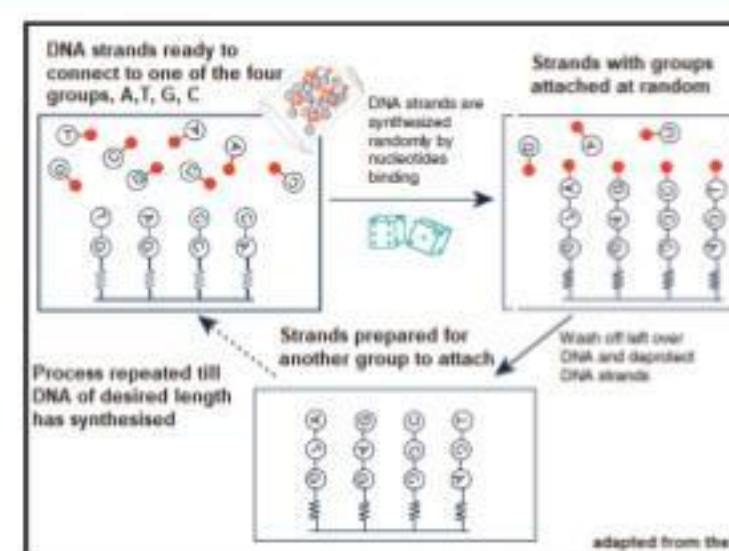
A problem with this particular method is that an intruder could cause the computer to crash, so that it restarts, usually within a minute. Now, the intruder knows that the time of start is one of the millisecond counts within that minute. As a minute has 60 seconds, there are only 60,000 milliseconds to try out, before the start for generating the random number, which is also known as the "seed", is discovered.

The trouble with random numbers which depend on a "seed" (these are known as "pseudo-random" numbers), is that they can be worked out once the "seed" is detected. Other sources, often of "true" random numbers, could be the unpredictable fluctuations in the electrical resistance of a conductor, known as "thermal noise", or even the phase of pulses of light generated by a laser. The methods, however, are cumbersome and often have limitations.

In contrast, the paper in *Nature Communications* says, are chemical reactions, where different products of chemical combination, although they arise according to a specific average rate, arise randomly, and could help generate random numbers. The problem, however, is that it is only the average that can be measured – the individual molecules that form cannot be labelled and identified.

It is of this difficulty that the group has succeeded in finding a way around. The DNA molecule, which is there in every living cell, with all the information about the organism, is a clear sequence of specific chemical groups, called "side chains", that are attached to a backbone. In the DNA of a living thing, the groups along the length of the DNA are fixed and are the same for all the cells of an individual. Therefore, when the two strands of the molecule separate, at the time of cell division, the strands are able to recreate the original DNA in daughter cells.

The researchers hence set out not with a DNA molecule, but with a strand of the backbone on which chemical groups attach, to form the DNA molecule. When placed in a bath of the four known chemical groups, the so called, A, T, G and C, whose sequence is what the DNA molecule is, these groups are attached to the backbone, one after the other, with equal probability, but quite unpredictably. The sequence of groups



in the strand of DNA was hence a true random number – one that arose without the need to be worked out from a "seed". DNA backbones that are allowed to build up the sequence of "side chains" in a bowl of the correct chemical groups, would hence grow into a collection of true random numbers, each one as long as the operative part of the backbone. As we now have efficient methods to read out the sequence of groups in DNA molecules, the process could be automated, to create vast libraries.

The group got DNA strands synthesised, in this way, by specialised, commercial laboratories, and the sequences produced were analysed for randomness. After employing well known techniques to eliminate biases that the process introduces, the sequences "passed every test, with a score that surpassed the statistical minimum," the paper says. As DNA is both compact and robust, and can be preserved and transported with ease, DNA could soon join the forefront of Random Number Generators that are commercially available, the paper says.

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PLUS POINTS

Indigenous invention



Researchers at the Indian Institute of Technology-Madras have developed a solar-powered unmanned autonomous survey craft for Indian ports and inland waterways. It can undertake autonomous hydrographic and oceanographic surveys and provide real-time data transmission over long distances.

The system can be equipped with an echo sounder, GPS system and broadband communication technology, capable of delivering precise depth measurements. In addition to an echo sounder and GPS system, it is possible to add additional oceanographic payloads (current and velocity measurements), 360-degree camera, LiDAR for seamless topography and bathymetry measurements. The autonomous survey craft was developed by a research team at the National Technology Centre for Ports, Waterways and Coasts in IIT-Madras.

Professor K Murali, Professor In-Charge, NTCPCW, IIT-Madras, said, "This is a significant leap towards indigenisation of the Indian maritime sector, which is currently dominated by foreign technology. The craft can deliver precise and accurate depth measurements even in very shallow waters. This autonomous survey craft will help to meet the increasing demands for volume and efficiency as ships are becoming larger, with maximum loading to ensure most efficient operations."

Murali, who is also the head, department of ocean engineering, IIT-Madras, said, "The craft can undertake autonomous hydrography surveys at different times of the day to identify the navigable paths that can be used for operational window and navigational guidance. It has been developed to carry out survey operations in areas such as ports, harbours, waterways, dams, lakes, lagoons and other shallow water zones. It can be operated in manual mode by a remote-control setup or as a fully autonomous vehicle."

In addition, it can help some challenges that are being frequently encountered by port administrators in India like:

- Surveys slow down busy heavy traffic and even causing accidents
- Vessels to carry out the survey in the shallow area
- The high cost for periodical channel surveys

The craft is fully solar-powered. It can work five to several more hours depending on user requirements.

The research team included Murali, D Leo (principal scientist, NTCPCW) and D Kumaran Raju (Principal Scientist, NTCPCW). The survey craft development is part of the research funding provided to the NTCPCW by the Union ministry of shipping. The craft had a successful field-test recently off the Chennai coast at Kamarajar Port. Further field trials under harsher environments have been scheduled at Shyama Prasad Mookerjee (SMP) Port, Kolkata.

Getting closer

The Earth is 2,000 light-years closer to a black hole than we previously thought, new research has revealed.

The finding comes from the Japanese radio astronomy project Vera (VLBI Exploration of Radio Astrometry), which has been mapping three-dimensional velocity and special structures in the Milky Way since 2000. The scientists used a technique called interferometry – which combines the interference of light, radio, or sound waves from two or more telescopes to get a detailed picture of the sky – on information gathered from radio telescopes across Japan. This means that it can map with the same resolution as a 2,300km-diameter telescope would have; for comparison that resolution (10 micro-arcseconds) is enough to resolve a penny that has been placed on the moon.

Based on this catalogue, and recent observations from other astronomers, the scientists constructed a position and velocity map and calculated the centre of the galaxy – home to the supermassive black hole Sagittarius A*. The map suggests that the centre of the galaxy is located 25,800 light-years from Earth, rather than the official value of 27,700 light-years that has been used by the International Astronomical Union since 1985.

This new data also indicates that Earth is travelling faster than previously thought, moving at 227 km/s (kilometres per second) around the Galactic Centre rather than the official value of 220 km/s.

This new research, called "The First VERA Astrometry Catalog", is available in *Publications of the Astronomical Society of Japan*.

—THE INDEPENDENT



JANET M GIBSON

Amusement and pleasant surprises – and the laughter they can trigger – add texture to the fabric of daily life.

Those giggles and guffaws can seem like just silly throwaways. But laughter, in response to funny events, actually takes a lot of work, because it activates many areas of the brain: areas that control motor, emotional, cognitive and social processing.

As I found when writing *An Introduction to the Psychology of Humour*, researchers now appreciate laughter's power to enhance physical and mental well-being.

Laughter's physical power

People begin laughing in infancy, when it helps develop muscles and upper body strength. Laughter is not just breathing. It relies on complex combinations of facial muscles, often involving movement of the eyes, head and shoulders.

Laughter – doing it or observing it – activates multiple regions of the brain: the motor cortex, which controls muscles; the frontal lobe, which helps you understand context; and the limbic system, which modulates

positive emotions. Turning all these circuits on strengthens neural connections and helps a healthy brain coordinate its activity.

By activating the neural pathways of emotions like joy and mirth, laughter can improve your mood and make your physical and emotional response to stress less intense. For example, laughing may help control brain levels of the neurotransmitter serotonin, similar to what antidepressants do. By minimising your brain's responses to threats, it limits the release of neurotransmitters and hormones like cortisol that can wear down your cardiovascular, metabolic and immune systems over time. Laughter's kind of like an antidote to stress, which weakens these systems and increases vulnerability to diseases.

Laughter's cognitive power

A good sense of humour and the laughter that follows depend on an ample measure of social intelligence and working memory resources.

Laughter, like humour, typically sparks from recognizing the incongruities or absurdities of a situation. You need to mentally resolve the surprising behaviour or event – other-

wise you won't laugh; you might just be confused instead. Inferring the intentions of others and taking their perspective can enhance the intensity of the laughter and amusement you feel.

To "get" a joke or humorous situation, you need to be able to see the lighter side of things. You must believe that other possibilities besides the literal exist – think about being amused by comic strips with talking animals, like those found in "The Far Side."

Laughter's social power

Many cognitive and social skills work together to help you monitor when and why laughter occurs during conversations. You don't even need to hear a laugh to be able to laugh. Deaf signers punctuate their signed sentences with laughter, much like emoticons in written text.

Laughter creates bonds and increases intimacy with others. Linguist Don Nilsen points out that chuckles and belly laughs seldom happen when alone, supporting their strong social role. Beginning early in life, infants' laughter is an external sign of pleasure that helps strengthen bonds with caregivers.

Later, it's an external sign of shar-

THE POWER OF HUMOUR

Laughing is good for your mind and body - here's what the research shows

ing an appreciation of the situation. For example, public speakers and comedians try to get a laugh to make audiences feel psychologically closer to them, to create intimacy.

By practising a little laughter each day, you can enhance social skills that may not come naturally to you. When you laugh in response to humour, you share your feelings with others and learn from risks that your response will be accepted/shared/enjoyed by others and not be rejected/ignored/d disliked.

In studies, psychologists have found that men with Type A personality characteristics, including competitiveness and time urgency, tend to laugh more, while women with those traits laugh less. Both sexes laugh more with others than when alone.

Laughter's mental power

Positive psychology researchers study how people can live meaningful lives and thrive. Laughter produces positive emotions that lead to this kind of flourishing. These feelings – like amusement, happiness, mirth and joy – build resiliency and increase creative thinking. They increase subjective well-being and life satisfaction. Researchers find that these positive emotions experienced with humour and laughter correlate with appreciating the meaning of life and help older adults hold a benign view of difficulties they've faced over a lifetime.

Laughter in response to amusement is a healthy coping mechanism. When you laugh, you take yourself or the situation less seriously and may feel empowered to problem-solve. For example, psychologists measured the frequency and intensity of 41 people's laughter over two weeks, along with

their ratings of physical and mental stress. They found that the more laughter experienced, the lower the reported stress. Whether the instances of laughter were strong, medium or weak in intensity didn't matter.

Maybe you want to grab some of these benefits for yourself -- can you force laughter to work for you?

A growing number of therapists advocate using humour and laughter to help clients build trust and improve work environments; a review of five different studies found that measures of well-being did increase after laughter interventions. Sometimes called homeplay instead of homework, these interventions take the form of daily humour activities -- surrounding yourself with funny people, watching a comedy that makes you laugh or writing down three funny things that happened today.

You can practise laughing even when alone. Intentionally take a perspective that appreciates the funny side of events. Laughing yoga is a technique of using breathing muscles to achieve the positive physical responses of natural laughing with forced laughter (ha ha hee hee ho).

Researchers today certainly aren't laughing off its value, but a good deal of the research on laughter's influence on mental and physical health is based on self-report measures. More psychological experimentation around laughter or the contexts in which it occurs will likely support the importance of laughing throughout your day, and maybe even suggest more ways to intentionally harness its benefits.

The writer is professor of cognitive psychology, Grinnell College, US. This article first appeared on www.theconversation.com

