The Idea Carnival

A collection of brief, entertaining expositions

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M y articles normally expend many words on few topics. This one expends few words on many topics. I often find subjects interesting that don't need lengthy treatments, and it hasn't escaped my attention that the Internet is gradually abandoning words altogether. I don't plan to go to that extreme, but I've always respected efficient word use and I'm sure many readers will accept — perhaps even celebrate — brief expositions. Here we go ...

Sino-students

There are more people learning English in China than there are English speakers in the U.S.[1]

Mid-course Incorrection

On September 15, 1999, the NASA Deep Space network radioed a mid-course correction burn to the Mars Orbital Surveyor spacecraft, then approaching the Red Planet. A few days later, instead of skipping off the Martian atmosphere in an aerobraking maneuver as planned, the spacecraft plowed into the densest part of Mars' atmosphere and disintegrated. Later investigation revealed that the spacecraft required its burn instructions to be expressed in Metric units (newton-seconds), but because of a mixup, English units (pound-seconds) were transmitted, which resulted in the spacecraft's destruction. The total cost for the mission was US$655.2 million.[2]
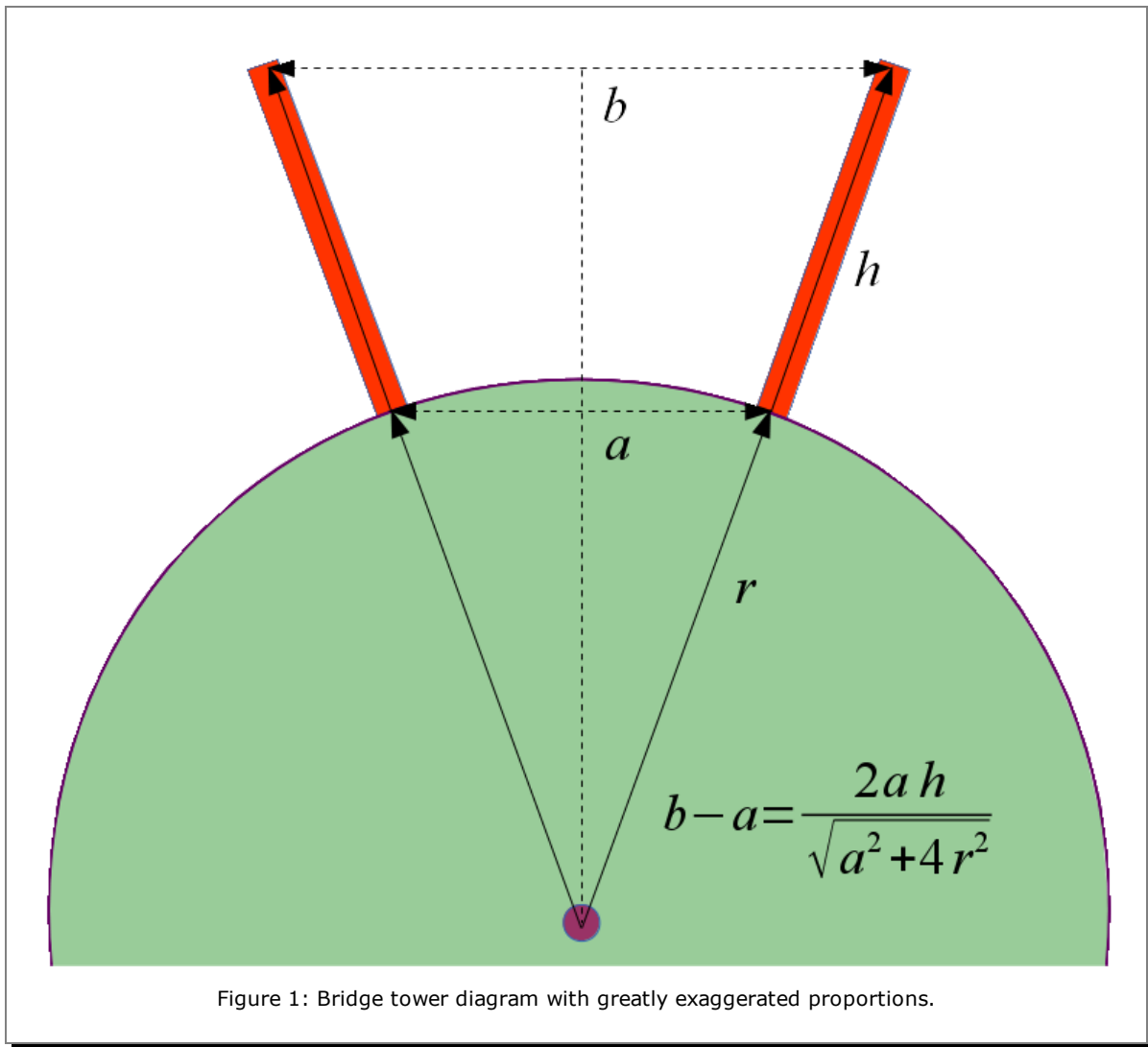
Bystander

A few minutes after President John Kennedy was shot in Dallas, Texas, a policeman ran into the building from which the shots were fired and accosted a man leaving the building. Because he was able to prove he was an employee of the Texas School Book Depository, the officer let the man go. Thus did Lee Harvey Oswald walk away from the crime of the century.[3]

Vertical

The towers of the Golden Gate Bridge in San Francisco are 1,280.2 meters (4,200 feet) apart and 227.4 meters (746 feet) high. Here are some facts about the bridge:

- The towers are perfectly vertical. If a weighted plumb line were to be placed alongside the centerline of the towers, it would align itself precisely with the towers from top to bottom.

- The towers aren't vertically aligned with each other — the horizontal separation between the towers' centerlines is 4.6 centimeters (1.8 inches) greater at the top than at the bottom.

Both these statements are true. The reason both are true simultaneously is that the earth's surface is curved, consequently the two perfectly vertical towers' horizontal separation produces a small difference in their angles with respect to the center of the earth ([click here](#) for a diagram).[4]

$$b-a=\frac{2a\,h}{\sqrt{a^2+4\,r^2}}$$

Figure 1: Bridge tower diagram with greatly exaggerated proportions.

Horizontal

Here's another geometry fact: For a sailor sitting on a boat, six feet above the water, the horizon is three miles away[5]. In many places on earth's oceans, this means *the bottom of the ocean is farther away than the horizon*. If our imagined sailor were traveling over the Mariana Trench in the western Pacific ocean, the ocean's bottom would be more than twice as far away as the horizon. Click here   for a diagram.
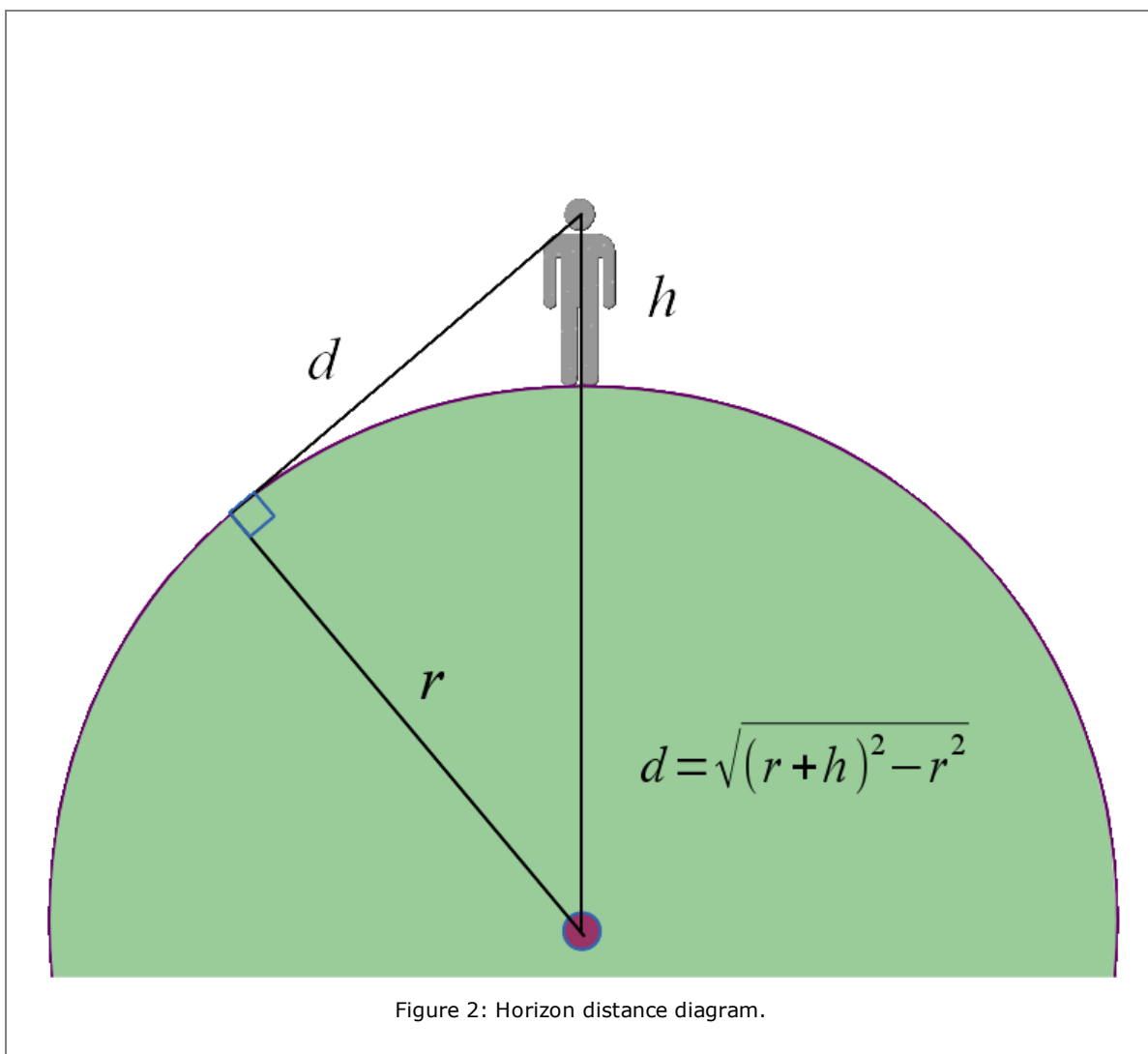
Figure 2: Horizon distance diagram.

$$d = \sqrt{(r+h)^2 - r^2}$$

Wildfire

On August 5, 1949, a team of 15 smokejumpers parachuted into a fire in Montana's Mann Gulch. Then the wind grew stronger and the fire became what's called a "blow up", a fire able to spread faster than a man can run. The firefighters realized the fire was approaching faster than they could escape through the unburned brush. Thinking quickly, Wagner Dodge, the foreman and most experienced person, took out a match and started a downwind fire along a likely escape path. Dodge tried to encourage the others to follow him into the wake of his escape fire, but the other men, not understanding his plan and beginning to panic, broke and ran in all directions to escape the flames. Dodge's downwind fire quickly burned itself out, providing a safe escape path ... for Wagner Dodge, one of just three men who survived the infamous Mann Gulch Fire.[6]

Extinction

70,000 years ago a gigantic volcanic supereruption known as the Toba event[7] took place in what is now Indonesia. The eruption was so massive that it triggered a nuclear winter[8] that nearly wiped out the human race. Modern genetic analysis[9] shows that the eruption and its aftermath reduced total human numbers to between 3,000-10,000 individuals. If the lower number is correct, this means there are 2.3 million times more people alive now. It also means there are more people living in a typical city block than existed on the entire planet at that time.

Literally

We should remember that dictionaries don't tell us what words mean, they tell us *what people think* words mean. This is why the words "literally" and "figuratively" mean the same thing.[10]

Market Prediction

Let's say John Doe wants to make money investing in stocks. Through the mechanism of *puts and calls*[11], John can make money whether the market rises or falls. But John needs a strategy, a way to decide whether the market will rise or fall in the future. Is such a strategy possible?

There are stories about very successful investors, people who seem to have an winning strategy to make money. But a theory called the Efficient Market Hypothesis (EMH)[12] says that such a strategy isn't possible, that the market's workings are too unpredictable to allow a consistent winning strategy. (No one knows whether the EMH applies to real

markets.)

Certainly some people make much better than average investment returns, but why? A scientist examining these outcomes would use the *null hypothesis*[13] as her starting point — the assumption that an outcome results from chance, not design. Assuming the null hypothesis, we can compute the probability that the picks of successful investors can be explained by the random workings of nature or by flipping a coin in a back room. Here are some facts about the role of chance in investing:

- The probability that an investor will correctly guess the market's direction (up or down) once is 1/2 or 50%.
- The probability for two sequential correct guesses is 1/4 or 25%. This probability is expressed mathematically as $p = 2^{-2}$.
- Now we can write a rule: the probability that n sequential correct binary (up/down) guesses arose from chance is $p = 2^{-n}$.
- Let's say we hear of an investor who correctly guessed the market's direction *twenty times in an unbroken sequence* and made a fortune. Isn't that proof of genius? Well, maybe, but chance must always be taken into account. In this case, the probability that this outcome arose from chance is 2^{-20} or 1/1,048,576.
- Many people might think the above outcome, with its very small chance probability, proves genius, but it overlooks something — it's the outcome for just one person, and there are millions of investors trying to guess the market's direction.
- What is the probability that, in a population of a million investors, one of them will make twenty sequential correct predictions by chance alone? It's 61%[14], which means when we hear an investment success story, the most likely explanation is chance, not genius.
- Next question: In a population of a million investors, will that one lucky investor assume his success resulted from chance, or will he write a useless investment book titled "Secrets of the Winners"?

Rich and Poor

According to an old saying, the rich get richer and the poor get poorer. It may be a folk saying, but there's a force at work in society that, if unchecked, can make it inevitable that the rich get richer and the poor get poorer. That force is called "compound interest"[15]. In compound interest, a periodic interest amount is (for an investment) added to, or (for a loan) subtracted from, the balance in an account. This compounding effect causes the account's balance to greatly increase or decrease over time, in a way that many people find surprising.

Here's an example. At age 20, a young man inherits $20,000 and decides to put the money in an investment that earns 12% per annum. His plan is to maintain the investment until he's 60 and retires. He also wants to withdraw a small amount of money weekly, but he wants to choose an amount that won't erode the account's value. Here are the details so far:

- Initial balance: $20,000.00
- Annual interest return: 12%, compounded weekly
- Weekly withdrawal: $46.15

As it turns out, the chosen weekly withdrawal amount prevents the account from either increasing or decreasing in value over time — after 40 years, the account still has a balance of $20,000.00. But consider these alternatives:

- If the withdrawal amount is increased by only 39 cents (less than 1%), to $46.54, the balance after 40 years will decline to zero.
- If the withdrawal amount is decreased by 38 cents to $45.77, the balance after 40 years will double to $40,000.00.
- If the man decides to forgo weekly withdrawals altogether, the balance after 40 years will grow to over 2.4 million dollars.

Click here   for a graph of these outcomes.

Figure 3: Effect of weekly withdrawal amounts on final balance.
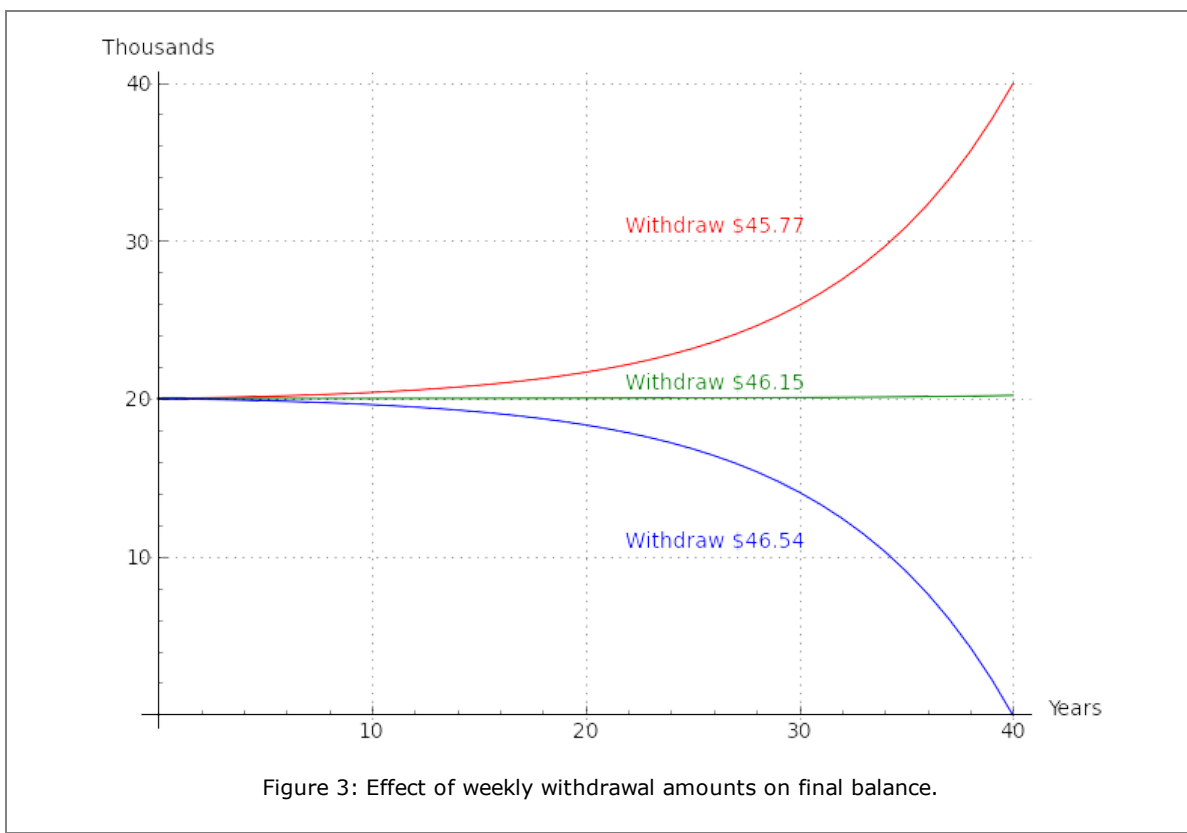
This section is only meant to describe a mathematical property of compound interest, not become a political discussion — I'll leave that to others. All this treatment shows is that compound interest produces instability and has the effect of turning a homogeneous society into a pyramid with increasing numbers of poor people at the bottom and a small handful of very rich people at the top. Is that a problem? Should something be done about it? Let the voters decide.

Watts Towers

Simon Rodia was an Italian immigrant construction worker who in his spare time built large sculptures out of found materials — construction rebar, steel pipes, bed frames, pottery, glass — anything he could find. From 1921 to 1954 Rodia added to his collection of sculptures, then, annoyed by his hostile neighbors, he moved away never to return.

The sculptures he left behind produced a mixture of responses, some admiring, some hostile. Eventually the City of Los Angeles deemed the structures hazardous — after all, they were built out of found scraps by a single person without any engineering training — so the city condemned them and ordered them razed.

Before serious demolition got underway, a preliminary test was performed to see what kind of equipment would be needed to tear down these makeshift structures. A heavy construction crane was brought up to the site and its steel grappling cable attached to one of the towers. The crane was powered up and the cable grew taut. Onlookers closely watched to see if the towers moved under the crane's force, but before any movement could be seen and according to contemporary accounts, the crane "experienced a mechanical failure", the test was called off, and the city abandoned its plan to demolish the towers.

Today the towers, now called the "Watts Towers of Simon Rodia State Historic Park", are maintained by the city and county of Los Angeles. The towers are listed in the National Register of Historic Places and were designated a National Historic Landmark in 1990.[16]

Simon, wherever you are, my hat's off to you.

Calculation

In 1873, English amateur mathematician William Shanks set out to compute the numerical value of π, using Machin's formula[17]:

$$\pi = 16 \, tan^{-1}\left(\frac{1}{5}\right) - 4 \, tan^{-1}\left(\frac{1}{239}\right)$$

After computing 707 decimal places Shanks stopped, having decided he had produced enough resolution for any earthly purpose. His extraordinary result stood for many decades until the advent of mechanical calculation in the 1940s, at which point another mathematician discovered Shanks' result was in error past the 527th digit. On this basis, one could say Shanks' result was 74.5% right.

A recent (2011) computer calculation produced ten trillion (10^{13}) digits of π, but now that computer power and leisure time are both ubiquitous, any such record is fated to be short-lived.

Because π is irrational (inexpressible as the ratio of two integers) its decimal sequence is infinite, and because its digits appear to be normally distributed[18], one often hears the claim that if π's digit sequence were to be expressed in base 26 (i.e. alphabetic letters), every work of literature that has ever been written, or will ever be written, would appear somewhere within the sequence. The claim is true, but there's the daunting problem of locating those particular sequences.[19]

Divide and Conquer

In 1996, for its role as a test bed for the U.S. Navy's "Smart Ship" program, the 9,800-ton displacement cruiser U.S.S. Yorktown (DDG-48/CG-48) was equipped with 27 Pentium Pro-based computers running Windows NT 4.0 and communicating over a fiber-optic cable network. The purpose of Smart Ship was to rely on computer automation to reduce the size of the crew required to operate a capital ship.

On September 21, 1997, while Yorktown was on maneuvers off the coast of Cape Charles, Virginia, a crewmember entered a zero into a database field that required a nonzero value. The crewmember's entry caused a divide-by-zero database error, which caused a workstation failure, which caused a network failure, which caused the Yorktown's propulsion system to fail. The Yorktown had to be towed back to port.[20]

Semmelweiss

In 1847, Viennese physician Ignaz Semmelweiss discovered that the rate at which women died in childbirth was 10%-35% in doctor's wards, three times higher than the rate in midwive's wards. The only real difference between the environments was that the midwives washed their hands between clinical procedures, and the doctors did not. Semmelweiss proposed that doctors wash their hands between procedures using a chlorinated lime solution, a suggestion known to be very effective, reducing death rates below 1%, but one that doctors rejected as insulting and beneath them.

In 1865 Semmelweiss suffered a mental breakdown and was committed to an asylum. Two weeks later he was severely beaten by the guards and died at age 47.[21]

After his death Semmelweiss' theories were vindicated by the work of Louis Pasteur[22], Joseph Lister[23] and others, who established a scientific basis for germ theory and designed antiseptic procedures and treatments ... including making doctors wash their hands.

MRSA

When antibiotics saw first practical application in the 1940s, many believed this marked the end for a large class of diseases including Tuberculosis, Bubonic plague and others, as well as being an effective treatment for everyday but life-threatening infections. But as time passed, bacterial agents began to show resistance to antibiotics, which resulted in a cycle of introducing replacement drugs, then watching resistant strains develop that required newer drugs.

The reason antibiotics become ineffective over time is provided by the theory of evolution by natural selection. When a new antibiotic is first applied it wipes out nearly all the bacteria, except a very small minority that happen by chance to be resistant to the drug. Those few survivors eventually become the entire bacterial population, which requires application of a newer drug.

A particularly severe example of this gradual evolution of resistance, one that may prove to be a harbinger for the future of all antibiotic treatments, is Methicillin-resistant Staphylococcus aureus (MRSA)[24], an infectious organism that first appeared in hospital wards in Western Europe and Australia in the early to mid-1960s. From its status as a laboratory curiosity in the 1960s, MRSA has managed to spread across the world and develop resistance to all antibiotics applied to it. It has evolved into a particularly dangerous iatrogenic (hospital-borne) infection that killed about 19,000 U.S. patients in 2007. The present situation is now so serious that the danger from MRSA in a hospital ward is often greater than the diseases for which people seek hospital admission.

But MRSA is only one example of the general decline in the effectiveness of antibiotics. Tuberculosis is another example of a disease with a long history, that at one time seemed to be fully controlled by antibiotics, but that now has forms that are essentially untreatable. Many other diseases that were thought to have been defeated by antibiotics are gradually reappearing in resistant forms. The problem of antibiotic resistance is now so serious and apparently insoluble that some are proclaiming the end of the antibiotic era.[25]

First Programmer

Augusta Ada King, Countess of Lovelace, daughter of Lord Byron, was born in 1815 and was from an early age encouraged by her mother to develop her mathematical and logical skills. She was then educated by a number of very talented men and women and became a skilled mathematician. As a young woman Ada befriended and began a working relationship with mathematician Charles Babbage, at the time working on a mechanical computer named the Analytical Engine. As the project unfolded, Ada's extensive notes on the Engine became a blueprint for imagined machines far beyond the technical possibilities of the time. Ada's notes include what is now recognized as the first computer algorithm, a method for computing a sequence of Bernoulli numbers which modern analysis shows would have worked, had the Analytical Engine actually been built.

Ada's extensive notes, on the Analytical Engine and on algorithms for it, were republished in 1953, at the beginning of the modern computer era. Ada's notes show that she had a deep understanding of a computer's possibilities, far beyond that of her contemporaries. In her notes, Ada says:

> [The Analytical Engine] might act upon other things besides number, were objects found whose mutual fundamental relations could be expressed by those of the abstract science of operations, and which should be also susceptible of adaptations to the action of the operating notation and mechanism of the engine...

Supposing, for instance, that the fundamental relations of pitched sounds in the science of harmony and of musical composition were susceptible of such expression and adaptations, the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent.

In 1852 Ada died of uterine cancer at the age of 36. In 1980 the computer language Ada, created on behalf of the United States Department of Defense, was named after Ada Lovelace.[26]

Pando

Also known as the Trembling Giant, Pando is a clonal colony of a single male quaking aspen (*Populus tremuloides*) joined by an underground root system. Genetic testing reveals that Pando is a single organism extending over 43 hectares (106 acres) and weighing approximately 6 million kilograms (13.2 million pounds), which makes it the heaviest known organism.

Pando's subsurface root system, which has survived any number of surface fires that killed the trees above, is estimated to be 80,000 years old, among the oldest living organisms. At any given time the colony has over 40,000 stems (trees) extending from its root system. The average age of one stem is 130 years before being replaced by another.

Pando is located at the western edge of the Colorado Plateau in South-central Utah, at Latitude 38.525° N, Longitude 111.75° W.[27] Click here   for a picture of Pando.

Figure 4: Pando in the fall (click image for larger size).

Note

Please visit again to see future additions to the Carnival.

Footnotes

- [1] A quarter of Chinese study English: official   — "More than 300 million Chinese people, or nearly a quarter of the country's population, have studied English either as a major course or as an elective subject ..."
- [2] Mars Climate Orbiter (Wikipedia)   — "The discrepancy between calculated and measured position, resulting in the discrepancy between desired and actual orbit insertion altitude, had been noticed earlier by at least two navigators, whose concerns were dismissed."
- [3] "Killing Kennedy", Bill O'Reilly & Martin Dugard, Henry Holt & Co. 2012, p. 265: "Dallas motorcycle officer Marrion L. Baker has raced into the building and up the stairs. He stops Oswald at gunpoint on the second floor but then lets him go when it becomes clear that Lee Harvey is a TBSD employee."
- [4] Golden Gate Bridge (Wikipedia)
- [5] Distance to the Horizon (Wikipedia)
- [6] Mann Gulch fire (Wikipedia)   — "With the fire less than a hundred yards behind he took a match out and set fire to the grass just before them. In doing so he [Dodge] was attempting to create an escape fire to lie in so that the main fire would burn around him and his crew. In the back draft of the main fire the grass fire set burned straight up toward the ridge above. Turning to the three men by him [...] Dodge said 'Up this way', but the men misunderstood him."
- [7] Toba catastrophe theory (Wikipedia)   — A scientific theory about a massive volcanic supereruption 70,000 years ago.
- [8] Nuclear Winter (Wikipedia)   — A theory about events, natural or man-made, that can trigger long-term catastrophic

cooling of Earth's climate.

- [9] Genetic Bottleneck Theory (Wikipedia)   — A theory about catastrophes that can greatly reduce species numbers, with the Toba event as an example.
- [10] Literally (Merriam-Webster)   — (1): in a literal sense or manner : actually <took the remark literally> <was literally insane>, (2): in effect : virtually <will literally turn the world upside down to combat cruelty or injustice — Norman Cousins>
- [11] Options: The Basics (Motley Fool)   — How to make money in stocks whether the market is rising or falling.
- [12] Efficient-market hypothesis (Wikipedia)   — a theory that, if true, would prevent a consistently winning investment strategy. (No one knows whether it's true.)
- [13] Null Hypothesis (Wikipedia)   — a scientist's default precept, that a given experimental outcome resulted from chance, not design.
- [14] We can use the Binomial Theorem (Wikipedia)   to compute that a million binary trials, each with a probability of 2^{-20}, has a 61% chance of one or more successes.
- [15] Compound Interest (Wikipedia)   — a property of certain bank accounts/loans that produce an exponential increase or decrease in the balance over time.
- [16] Watts Towers (Wikipedia)   — a somewhat strange, but very strongly built, example of what is called "vernacular architecture" in Los Angeles.
- [17] Machin's formula (Wikipedia)   — a formula for computing the numerical value of π.
- [18] Normal number (Wikipedia)   — a number whose digit sequence is uniformly distributed, i.e. each digit 0-9 has probability $p = 10^{-1}$ of appearing, each pair of digits has probability $p = 10^{-2}$ of appearing, and so forth.
- [19] π (Wikipedia)   — The ratio of a circle's circumference to its diameter.
- [20] USS Yorktown (CG-48) (Wikipedia)   — a U.S. Navy ship that had to be towed back to port as the result of an unhandled computer divide-by-zero error.
- [21] Ignaz Semmelweis (Wikipedia)   -- a misunderstood critic in the field of hospital antisepsis.
- [22] Louis Pasteur (Wikipedia)   -- a pioneer in the field of microbiology and germ theory, inventor of several early vaccines.
- [23] Joseph Lister (Wikipedia)   -- a pioneer in the field of antiseptic surgery who built on Pasteur's work.
- [24] Methicillin-resistant Staphylococcus aureus (Wikipedia)   -- a dangerous iatrogenic infection that has become a very serious public health problem.
- [25] Expert: 'The end of antibiotics, period' (UPI)   -- CDC official announces the end of the antibiotic joyride.
- [26] Ada Lovelace (Wikipedia)   -- daughter of Lord Byron, mathematician, now recognized as the first computer programmer.
- [27] Pando (Wikipedia)   -- A very large clonal colony of a single male Quaking Aspen.

Home | Articles | The Idea Carnival ▾ ◀ ⊞ Share This Page