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STEM NEWSLETTER



RSA ENCRYPTION

PROBABILITY

TOUCH SCREENS

and more...

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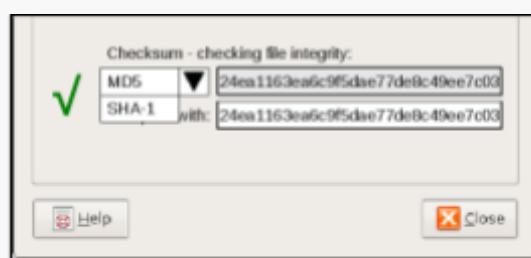
How Computers Hide Your Password

Aidan Hong

Most major websites require users to sign in to access data. Typically, signing in to a website involves using your username, email, and password. The password is the most sensitive part of the sign-in, and hackers mustn't find out what it is. As a result, websites employ hashes to protect passwords and stop hackers from finding your password. Hashes help protect passwords, as well as protect file integrity.

Hashing is a method websites use to obscure data. For example, a password of "letmein" could be hashed into a long and complex string. There is no way to reverse hash the password and find the original plaintext of the password. Additionally, there are many hash algorithms, for example, MD5, SHA-1, and SHA-256. As a result, many websites and companies use hashes to protect their user's passwords. It provides many benefits: hackers cannot find out what the original plaintext was and companies cannot find out what the original password was, giving the user peace of mind when it comes to security.

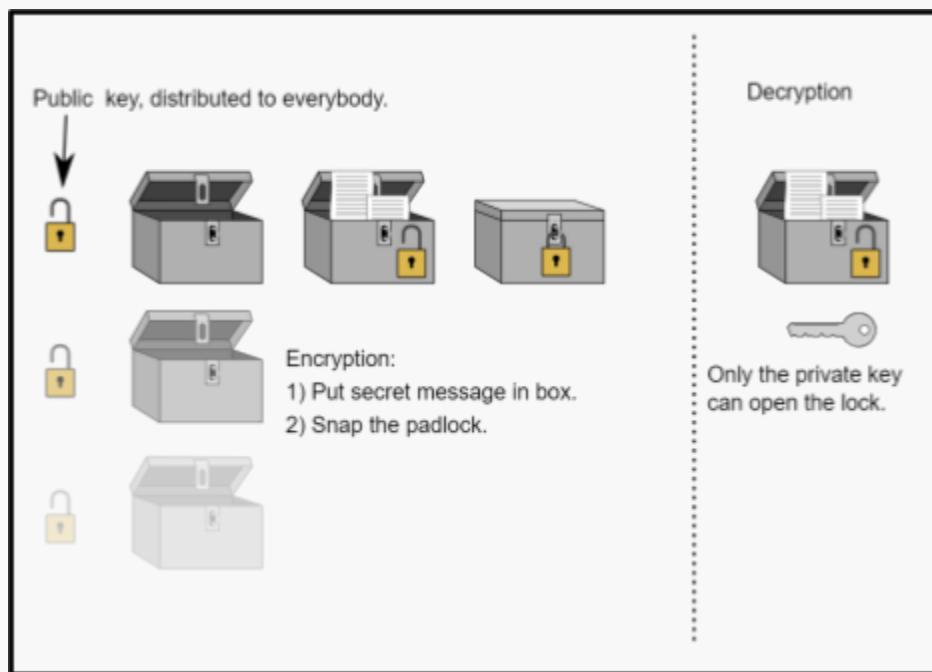
Hashes also have other applications as well. One other popular way hashes are used is to protect file integrity. Every file on your computer has a hash, and the hash changes every time a file is altered. If a hash of the file doesn't match the hash that the file was supposed to have, it means that the file has been altered and thus, is not the original file.



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Despite hashes having many benefits, it is not invincible to attacks. A popular tool known as Hashcat is used to crack hashes. Although hashes cannot be reversed, Hashcat cracks hash another way. A wordlist is imported into Hashcat and Hashcat finds

the hash of every word in the file. If a hash of a word matches the hash of a password, then the password is found and the hash is broken. However, the only way this could occur is if a hacker gains access to the plaintext passwords of a website. Good cybersecurity practice consists of only storing hashes and not the plaintext password itself, resulting in your password being secure and not vulnerable to hacks.



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Hashes are used for many things: obscuring data and protecting file integrity.

Hashes are secure and reliable because they cannot be reversed, disabling hackers from easily finding out the plaintext passwords. Although there are methods to crack them, it is typically infeasible to do so and uncommon.

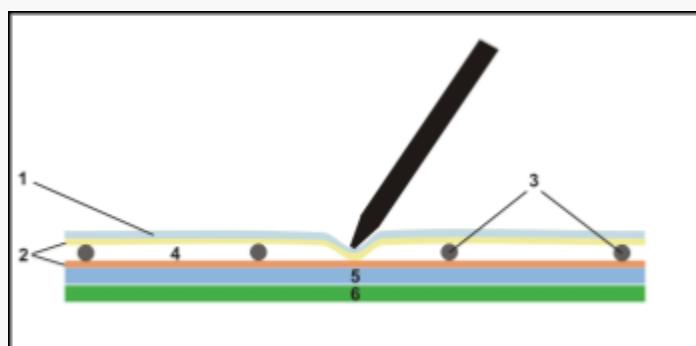
Behind the Touchscreen

Edward Huang

Every day, we carry an engineering marvel in our pockets – a portal to apps, games, and social networks at the tip of our fingers. The first touchscreen phone came out in the IBM Simon phone in 1992, and it soon became one of the most iconic features of a smartphone. Catching the world by storm, this seemingly magical interface would find its way into iPhones and Samsung Galaxy, with its design improving over time. But how is it possible? How can a phone detect where you press without any actual buttons? Let's swipe away the curtains and unpack the magic behind the smartphone touchscreen.

Most smartphone touchscreens use the *capacitive touchscreen* design. The screen is made up of a layer of LEDs for displaying visuals, glass, and a thin coating of indium tin oxide (ITO). ITO is both conductive and transparent, and this coating is connected to a small voltage so that there is constantly an electric current and charge on the screen. When you press your finger on the screen, some charge will leave the screen and flow into your finger, changing the electrostatic field of the screen. This change can then be detected, often with technologies on the edge of the screens that can determine the position at which the change is made.

This works because your finger is conducting, meaning that charge can flow from

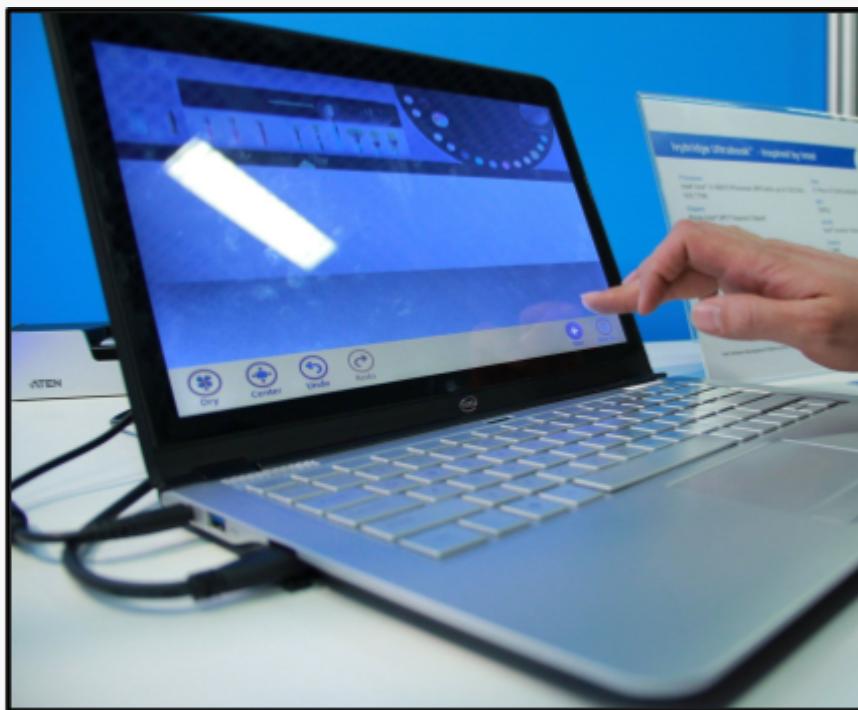


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the screen onto your finger. Wearing gloves or touching the screen with an insulator would be ineffective, some charge will not transfer onto an insulating object. Older touchscreens used the *resistive touchscreen* design, which

is a bit different. In this design, two layers coated with resistive material are pressed against each other when pressure is applied by a finger. These layers act as electrodes, and when connected, one sheet provides the x-coordinate of the connection and the other provides the y-coordinate. Together, the device can calculate the exact position of the press. Because this lies on pressure rather than capacitance, it is less sensitive than newer designs, but it comes with the benefit that the material touching the screen can be an insulator.

Behind the touchscreen lies a world of complex electrical technology, all thanks to our knowledge of physics, material science, and computing. We have invented a way for us to conveniently play games, look at websites, and scroll through social media posts with nothing but finger taps and swipes. Despite how magical it may seem, it's not magic, it's science.



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Sharks and Conditioning

Arick Hong

The two men cautiously enter the cage, oblivious to the danger that is waiting for them below. Men onboard the ship throw food into the water to attract large sharks. As they are lowered, the men are greeted by a large great white shark. From the shark's view, it's hungry, and the men seem to have no food on them. The shark knows that past divers have given him food, so he decides to find the food they are hiding. It strikes the cage with the force of a truck, and the men are thrown back into the cage. The shark gets excited by the chum in the water and strikes the cage again. It strikes it over and over again and even gets its head stuck in there before pulling it out. The reason for his behavior is simple: conditioning.

In 1897, Ivan Pavlov published the famous "Pavlov's Dogs" experiment. In this experiment, he rang a bell and fed dog meat. Every time the dog saw the meat, it began to salivate. He did this process multiple times until he rang the bell without giving it anything. When he did this, the dog salivated anyway, thinking that meat would be given. The same can be said with sharks. In places like Hawaii and the Bahamas, tourists like to go shark diving with extremely aggressive shark species, such as tiger sharks. Tiger sharks have been known to attack humans, and are typically listed as the 3rd most dangerous shark in the world, behind the great white and the bull shark. Divers would often feed them chopped fish such as mahi-mahi and tuna while on these diving tours. As a result, sharks would swarm them during this process.

Now that you know how sharks would swarm divers when they have food, what do you think would happen if a diver and a shark met, and the diver didn't have any food on him? The answer is simple: the shark would attack. On September 21, 2015, Hawaiian diver Braxton Rocha was out spearfishing when he was suddenly attacked by a large,

13-foot tiger shark. The shark bit him in the arm, and he had to be immediately rushed to the hospital. He was given stitches, and he survived the incident. When experts tried to solve this case, they were stumped. Typically, spearfishers are attacked by sharks after they have shot a fish because the blood the fish emits after getting shot by the speargun attracts sharks. However, Braxton's case was different. While he was a spearfisher, he did not shoot any fish yet, and he was out looking for one to shoot instead. The area he was in was a popular spot for shark diving, and the divers there would often feed the sharks bait. Experts found out that conditioning matched his case perfectly. The shark bit him in the arm, thinking that he would be giving out food for the shark, and the sharks in that area had been conditioned by other divers on tours. This saddened many experts that divers could somehow be able to cause another innocent diver to get attacked by a shark, and measures were taken to stop conditioning sharks.



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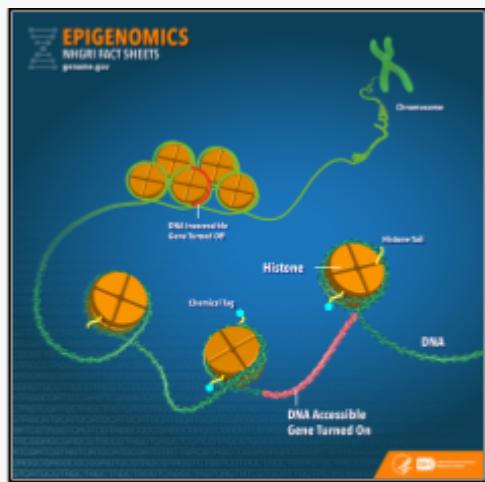
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The Switches of Genes

Arthur Liang

DNA and genes are the instructions for cells, telling them how to develop the human body as time goes on. However, your genetic sequence is static and can only be changed by unique forces such as radiation. If this is the case, then why do identical twins, who should have the same genetic code, sometimes develop diseases while the other twin does not? The answer lies in epigenetics, the switches that change gene expression.

So how does epigenetics tell genes to express themselves or not? Epigenetics

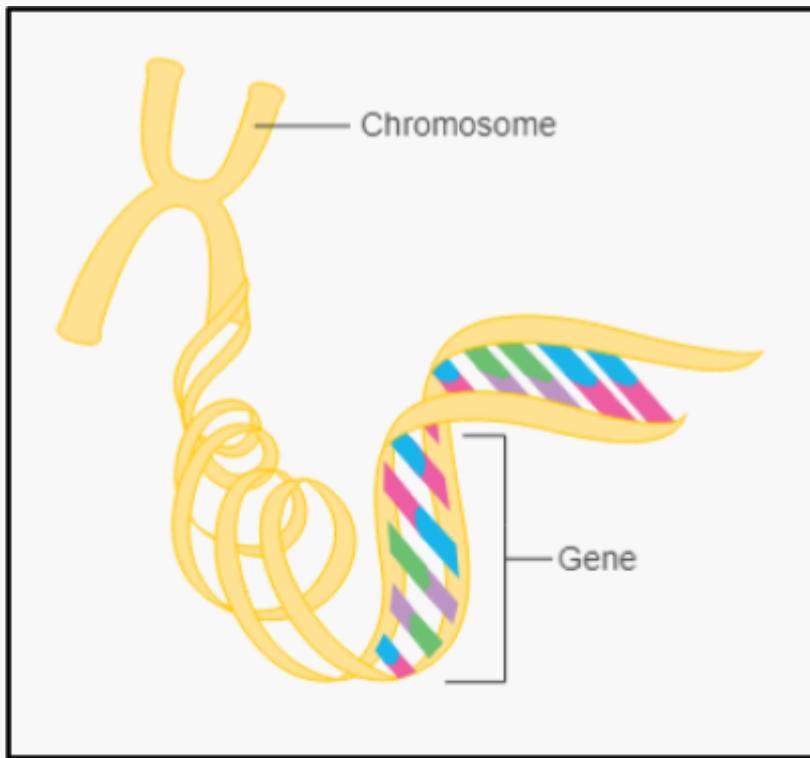


uses marks, or certain chemical compounds, to essentially turn genes on or off. One example of an epigenetic chemical is methyl, which attaches to DNA and silences a particular gene so that cells cannot read it, and therefore the gene cannot express. Another example is histone, which can change the structure and shape of the protein that the DNA is coiled around, causing the DNA to expand and certain genes to activate. This is why twins can develop different genetic conditions. Although their DNA

is the same, their epigenetics may not be.

As humans age and time passes, more and more epigenetic modifications to the DNA code can add up. This is because epigenetics turns genes on or off based on your lifestyle and experiences. As a result, older twins typically have more varied epigenetics compared to younger twins. It may also be the case that your experiences can cause epigenetics to affect DNA inside your reproductive cells, which pass on those genes to

your children. This means that your lifestyle can affect the genetics of your offspring as well, which comes with a sense of responsibility to take care of yourself.



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Scientists have been experimenting with epigenetic treatments of certain diseases such as cancer by altering the epigenetics of the infected cells. Epigenetics stands as the bridge between nature and nurture, the interface between the DNA you were born with and the experiences and outside world that you live through.

The Urgent Call for Clean Air

Audrey Don

No matter where you live, you can be exposed to air pollution from vehicle exhaust, smoke, road dust, industrial emissions, pollen, gas-fueled yard equipment, chemicals we use in our homes, and other sources.

The exigent call for clean air stems from the pervasive impact of air pollution on public health. Inhaling pollutants, present in conveyance exhaust, smoke, dust, industrial emissions, pollen, and household chemicals, sanctions them to enter the bloodstream. This exposure can lead to immediate discomfort such as coughing and itchy ocular perceivers. Moreover, it significantly contributes to the development or exacerbation of respiratory diseases, including asthma and chronic obstructive pulmonary disease (COPD/emphysema or chronic bronchitis).



Both short-term and long-term exposure to air pollutants pose solemn health threats, making it harder for people with pre-subsisting conditions to breathe, triggering asthma attacks, and causing wheezing and coughing.

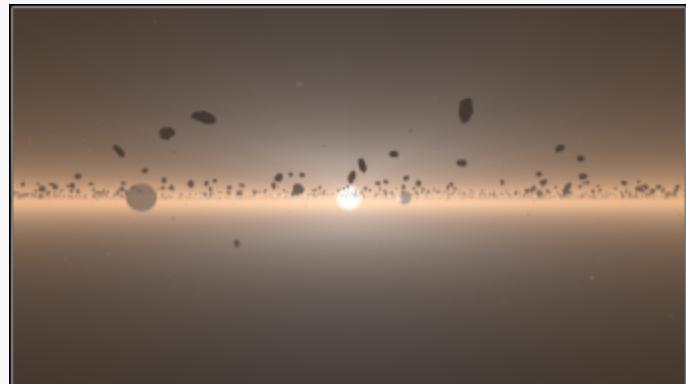
Furthermore, air pollution escalates the jeopardy of respiratory infections, heart disease, stroke, and lung cancer. Those already suffering from illnesses are disproportionately affected, heightening the urgency to address this issue promptly. Clean air is a critical imperative to safeguard public health, obviate hospitalizations, and mitigate the peril of cancer and premature death associated with protracted exposure to air pollutants.

The Birth of Our Solar System

Brandon Pian

Our solar system contains 8 planets and a dwarf planet containing from none to 146 counted moons. Each of these moons orbits their respective planet and each planet and 1 dwarf make an elliptical orbit around the sun. Before we existed about 4.5 billion years ago our solar system was a solar nebula with particles such as hydrogen and helium. Due to a nearby shockwave of a nearby exploding star the solar nebula collapsed.

The collapse of the solar nebula led to a spinning disk of particles that exploded due to the immense pressure it was under, leading to the formation of our sun. The creation of the sun took up 99% of the particles and the remainder of the materials floated away but due to the sun's gravity and inertia, they orbited the sun. Though the sun took up 99% of the materials there were still lots of debris left that collided with each other to make something bigger or they both exploded. The process by which objects collide with each other to make something bigger is called accretion. There are gas giants and rocky planets in our solar system because rocky planets formed near the sun gassy and icy material couldn't form due to the immense heat, but since the gas giants are farther away from the sun the gassy and icy material could build up on a small amount of rock. It took hundreds of thousands of years for most of the debris to be cleared up, but the planets were still extremely hot because of the collisions.

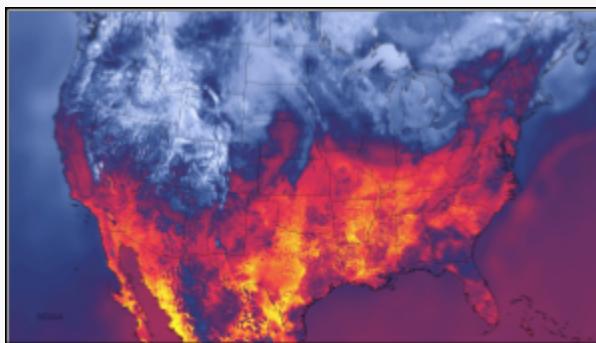


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Intricacies of the Butterfly Effect

Brandon Wang

The Butterfly Effect is a captivating concept where small changes or events in a system can cause unpredictable outcomes over time. For example, something minor like a flap of a butterfly's wings in Brazil could set off a chain of events that could cause a tornado in Texas. It was discovered by the American meteorologist Edward Lorenz (1917-2008), in 1963 and was considered one of the greatest achievements of twentieth-century physics. Lorenz discovered the Butterfly Effect by observing runs on his weather simulation utilizing a simple computer model. He wanted to repeat the



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simulation but began the second run in the middle using the numbers from the first run which gave numbers that had nothing to do with the previous ones. This proved that even tiny environmental disturbances could cause enormous climate changes.

Additionally, this concept can be applied in various fields, from meteorology to economics. Weather forecasters can

implement the Butterfly Effect to predict long-term outcomes with almost absolute certainty. Likewise, in economics, noticing small market alterations could escalate into a serious financial crisis over time. However, not only is the Butterfly Effect imposed for scientific purposes, but can be applied to our everyday lives. For instance, it could improve personal decision-making, knowing if a person you meet could positively or negatively impact you, taking small breaks to significantly impact academic performance, and benefit you financially. All in all, the Butterfly Effect invites us to embrace the unknown depth of the world and appreciate the beauty and the complexities of life.

What are the Chances? Probability in Video Games

Brian Wang

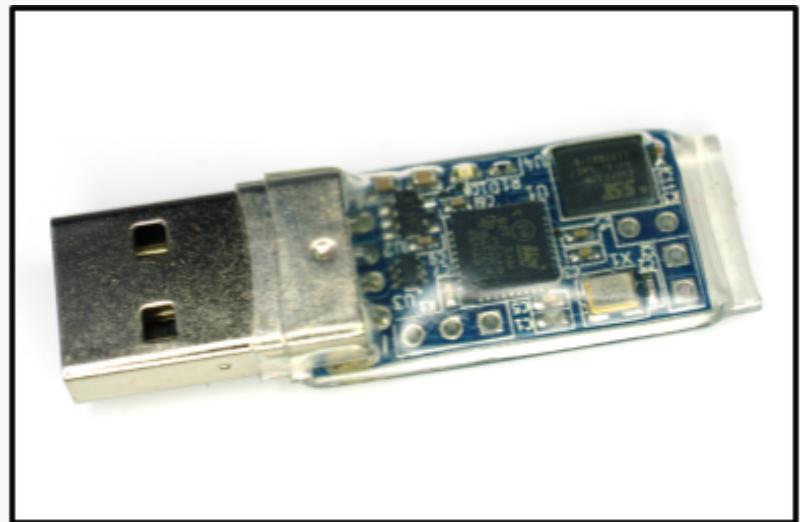
Many have played video games for the chance of obtaining an item, or the chance of finally being able to encounter a “shiny” Pokemon. This probability is what drives the addictiveness of video games. However, many often overlook the randomness of these in-game items. How are they calculated, and are they truly random? What if a video game intentionally makes the user get bad items until they’ve played for some time?

Computer randomness is generated in two main ways: true probability and fake probability. The main process by which a computer generates something random is through a seed. A random number generator is fed a random seed number, which results in multiple different patterns of numbers that may appear. In many video games, a random generator is often fed the default number of 0 or 1. As a result, the random generator produces predictable numbers, which makes the exploiting of this vulnerability easy. This is one of the many methods old games like Pokemon were exploited in old-school “hack programs”.



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The second method is through true probability. Though there will never be a true probability function in computers, there can be a much less predictable algorithm. For one, the seed must be random for each random generation. This is how games like Minecraft generate their terrain and worlds - through a random seed. However, that begs the question: how can we be sure the seed is random too? We cannot. Most of the time we can use an in-built function from a game engine or computer programming language library, such as C++ or Java, which provides `Math.random()` - with some additional modifications to the function.



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Some video games go further beyond true probability and find a real true probability algorithm. As an example, a physical device known as the hardware random number generator (HRNG) uses radioactive decay of isotopes and static to generate random numbers, which are fed into random generator functions.

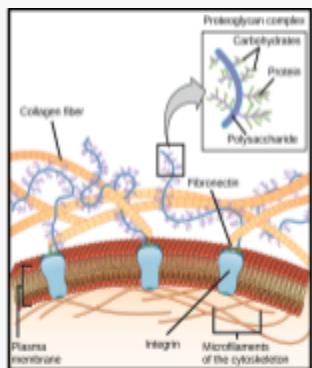
No matter what floats our boat in video games or life, we still live a life full of chances and risks. All we achieve comes from randomness, a process that takes the route of a thousand numbers, all behind the scenes hidden from us.

Culinary Alchemy: Dry Aging Steak

Cody Duan

Sometimes, a steak tastes much better than usual, and one such influence factor is dry aging. Put simply, dry-aging steak consists of leaving steak in the open for an extended period to let it develop flavors and tenderness. However, the process runs much deeper than hanging it to dry.

Enhanced flavors and tenderness come from multiple factors such as amino acids, fatty acids, enzymes, etc. Enzymes are the main element in steak enhancement, for they



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are a factor in flavor and tenderness development. Two types of enzymes, cathepsins, and proteases, break down protein fibers, which release peptides and amino acids that improve the savory and umami flavors of the meat. In addition, enzymes also break down collagen and connective fibers, which removes the meat's toughness, resulting in a more tender steak and a better perception of flavor.

A series of processes such as lipolysis and the Maillard reaction also play a crucial role in dry aging. In lipolysis, the fat breaks down into fatty acids and spreads throughout the meat, giving it a richer and more complex taste. Dry aging removes moisture from the steak, giving it a more concentrated flavor. The Maillard reaction then starts in the cooking process. When heat is applied, amino acids and reducing sugars react and form an unstable compound called glycosylamine, which undergoes more reactions. Consequently, a wide variety of complex compounds are created, resulting in two things, the brown color and a wider range of flavors. There are a lot more things that go on during the dry-aging process than just becoming dry, and it is one of the most interesting reactions that we see in the culinary field.

Unraveling Time Paradoxes

Denise Lee

The grandfather paradox is a fascinating, hypothetical concept in time travel theory. Like the name, the paradox is based on the idea that if a person traveling back in time attempts to prevent their existence by eliminating their grandfather before their parent is born, it would be impossible for them to be born. Thus, if they can't be born, the time traveler can't travel back in time and can't kill their grandfather. This raises the question of how their grandfather can be killed by someone who doesn't exist. The cyclic nature of this scenario creates a perplexing loop, hence the grandfather paradox. The paradox highlights the inherent complexities and logical challenges associated with time travel.

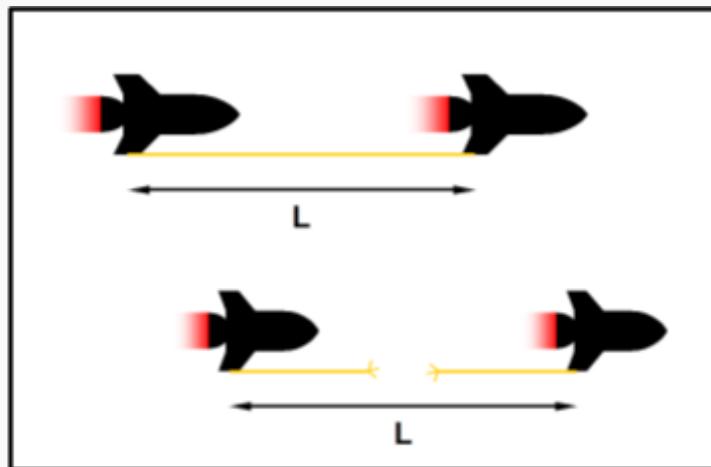
Another intriguing concept is the bootstrap paradox which occurs when information or objects are sent back in time, yet their origin becomes an infinite loop with no clear starting point. An illustrative example involves someone traveling back in time to give Walt Disney the idea for Mickey Mouse, but the time traveler originally gained the idea from Walt Disney. This recursive loop raises questions about the origin of the idea, as seemingly has no starting point.



it

Lastly, the predestination paradox, wherein the actions of individuals traveling back in time become an important factor in the events they aim to alter. This creates a "temporal causality loop" where Event A in the past influences Event B in the future, but for Event A to occur, Event B must happen, and vice versa. The paradox implies a

predetermined course of events, suggesting that attempts to prevent something in the past may contribute to its occurrence, forming a self-fulfilling prophecy.



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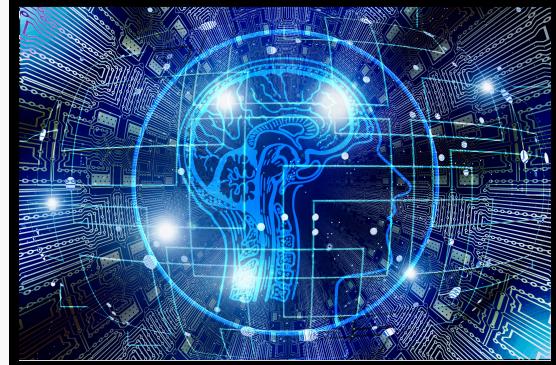
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What would happen if these time paradoxes were to happen? It's worth noting that, as of now, time travel remains a hypothetical concept, and our understanding of the laws governing time is limited. The solution to such paradoxes is purely speculative, as we currently lack the scientific means to explore and validate these theories. The grandfather paradox, along with other time travel conundrums, continues to fuel intriguing, thought-provoking discussions while remaining a fascinating aspect of theoretical physics.

Exploring the Mechanics of Neural Networks

Eddie Zhang

Neural networks, a cornerstone of artificial intelligence (AI), have transformed the landscape of machine learning. These computational models, inspired by the structure of the human brain, have become instrumental in enabling machines to learn and make decisions. This essay delves into the core principles of neural networks, shedding light on their structure, operation, and diverse applications.



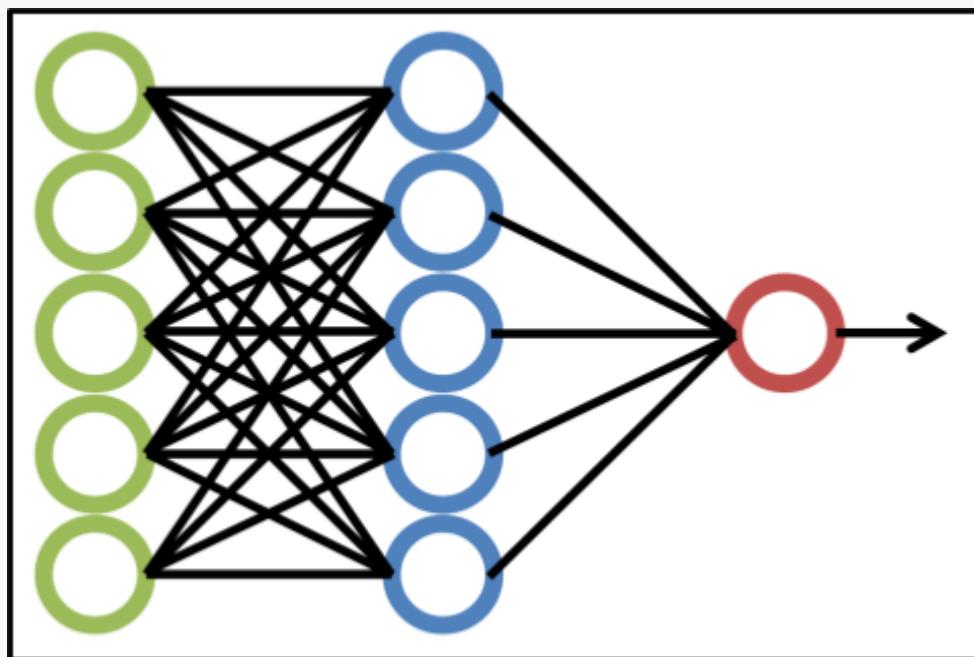
At its essence, a neural network comprises interconnected nodes or artificial neurons organized into layers: the input layer, hidden layers, and output layer. The connections between nodes carry weights that determine the strength of the connection. Neurons in each layer are activated through an activation function, introducing non-linearity to capture intricate patterns in data. The architecture varies, with deep neural networks having multiple hidden layers for complex feature extraction.

Neural networks learn through training, where they encounter a dataset with known inputs and outputs. The model adjusts its weights iteratively to minimize the difference between predicted and actual outputs, using optimization algorithms like gradient descent. Backpropagation is integral to this process, refining weights by computing the gradient of the error. This iterative adjustment empowers neural networks to master complex mappings, making them invaluable in tasks like image recognition and natural language processing.

Neural networks find applications across diverse fields. Convolutional neural networks (CNNs) excel in image recognition, while recurrent neural networks (RNNs) suit sequential data tasks like natural language processing. Generative models, such as generative adversarial networks (GANs), contribute to image synthesis and style transfer.

Despite successes, neural networks face challenges like interpretability and the need for extensive labeled datasets. Researchers are actively addressing these issues, exploring novel architectures and techniques. The future holds promise for more efficient algorithms, improved hardware, and the integration of neural networks with other AI approaches.

Neural networks mark a significant advancement in AI, enabling machines to learn and execute complex tasks. Unveiling the mechanics of neural networks offers insights into their potential and challenges, propelling further advancements in AI technology. As researchers continue refining architectures and algorithms, the trajectory towards smarter machines accelerates, ushering in a future where AI becomes increasingly integral in our daily lives.



What is Epigenetics?

Emily Wang

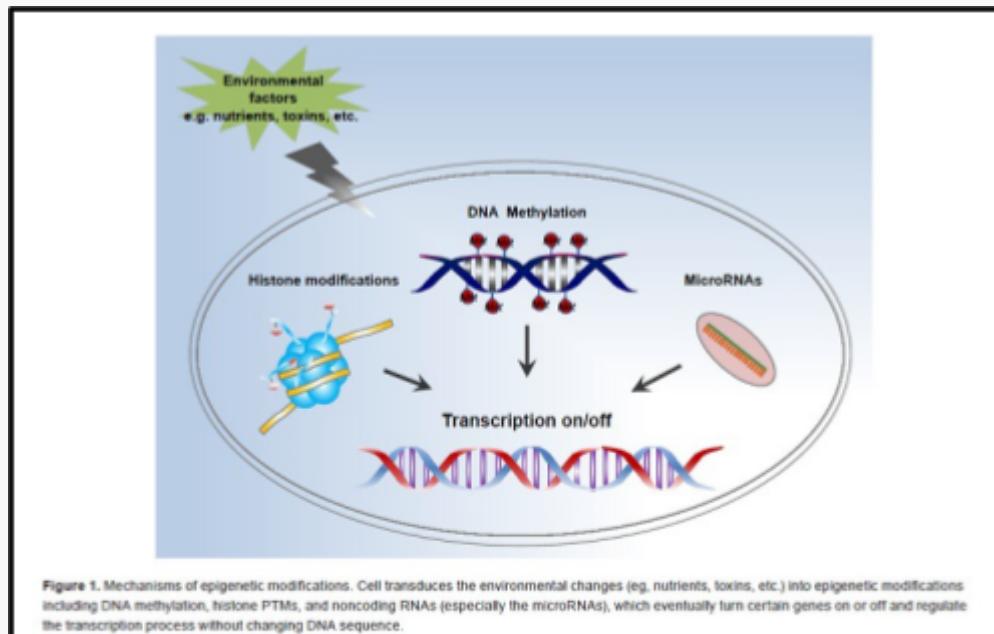
Epigenetics is the study of how your behaviors and environment can affect the way your genes work. Epigenetic changes are reversible and do not change your DNA, it only changes the way your body reads the DNA strands. These alterations begin before you are born. As you grow and develop, your epigenetic changes in the normal development of your age and response to your environmental exposures, behaviors, and experiences. Epigenetic modifications have serious effects on human health, which include risks of disease susceptibility, aging, and even mental health.

Epigenetic alterations can impact the risk of getting certain diseases. For example, DNA changes in methylation patterns and histone modifications have demonstrated developments in cancer, cardiovascular diseases, and neurologic disorders. Environmental factors such as exposure to pollutants, toxins, and bad air quality can also induce negative epigenetic changes. These ecological exposures can influence the health of a developing fetus, so it is important to do thorough research on the climate conditions of local areas. Mental health may also influence changes in your epigenetics. Stress, trauma, and other psychological factors can contribute to the growth of mental disorders such as depression, anxiety, and PTSD.



Although these outcomes can seem threatening, there are ways to prevent the changes from impacting your health. Better lifestyle choices, such as maintaining a beneficial diet, continuous exercise, and controlling stress levels can greatly decrease the risk of these alterations. Healthy lifestyle habits can promote positive epigenetic

changes that contribute to your well-being, while unhealthy habits may pose the opposite effect.



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Epigenetic research is still ongoing and continues to accentuate the understanding of human biology and the role of the environment on diseases and health issues. It is important to bear in mind that although these changes are reversible, they can also be heritable, meaning they can pass down from one generation to the next. Understanding these factors is significant in developing strategies to maintain good health and prevent various diseases.

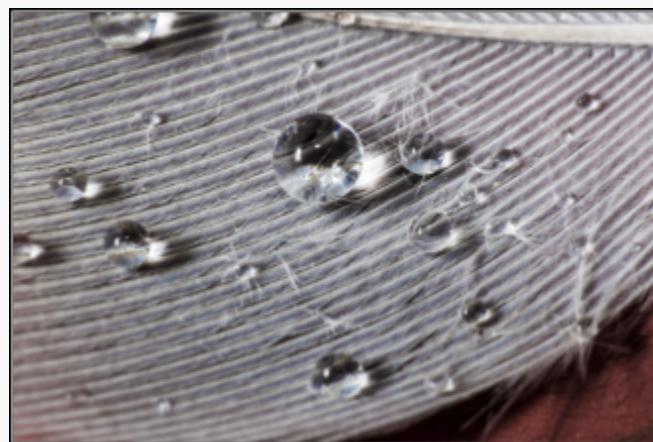
Nanotechnology: More Than Just “ 10^{-9} ”

Kenny Wu

Nanotechnology is a term no stranger to biomedical engineers. These technologies that were created in nanoscales have had a great impact on our everyday lives. The concept of Nanotechnology was first introduced in 1959, by the American physicist and Nobel Prize laureate Richard Feynman. Nanotechnology revolves around reshaping matters on an atomic scale to form new structures and benefits. There is an unlimited potential for nanotechnology in fields like medicine, consumer products, and manufacturing.

To begin, Nanotechnology offers several benefits to the medical field. The introduction of nanotechnology allowed the creation of a new subfield called nanomedicine. This field utilizes nanotechnology in drug delivery allowing Nanoparticles to be designed to deliver drugs to specific cells while reducing the side effects and improving the effectiveness of the treatment. As scientists persist in researching the use of nanotechnology in medicines, the influence of nanomedicines will continue to shine.

Furthermore, Nanotechnology plays a prominent role in consumer goods. Nanomaterials are often used for their unique properties of small size, for instance, nanoparticles are incorporated into textiles that could further improve the strength, flexibility, and durability of the product. Another function of

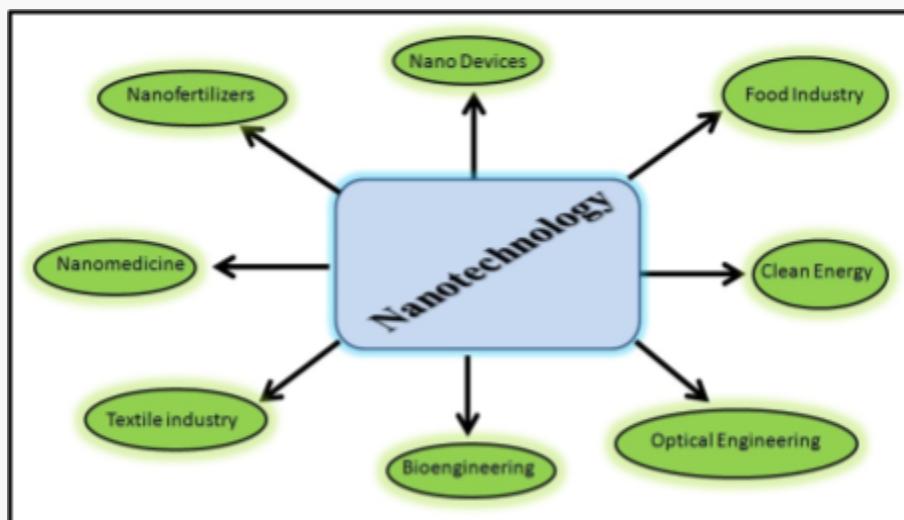


"Water droplets on hydrophobic feather!" from Nikk
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nanotechnology is nanocoating, where nanoparticles of hydrophobic materials are applied to fabrics, making them water-repellent and avoiding stains. Similar to the medical field, nanotechnology possesses an overwhelming power to boost the quality of consumer goods.

In addition, Nanotechnology is heavily invested in manufacturing. Many companies can design products that possess unique perks due to the use of nanoparticles. Some examples are resistant coatings, improved sunscreen, odor-resistant textiles, enhanced battery performance, and much more. The usage of nanotechnology in manufacturing is a black hole that knows no end.

All in all, the convenience and improvements nanotechnology has put on the table have exceeded the expectations of most people. We can be promised to see an even stronger usage of nanotechnology once scientists discover more traits about it. It is suggested that there is no limitation to the potential of nanotechnology, only the limitation of human creativity.



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Impact of Wireless Connections on the Human Body

Natalie Dai

With the rapid technological advancement in our society today, wireless connections have been a vital component of our daily lives because of their convenience and accessibility. However, there have been issues that raised concerns about how wireless connections affect the human body.

Wireless connections, otherwise known as Bluetooth, rely on RF, radio frequencies, to transmit data back and forth. RF is a type of non-ionizing radiation and is not strong enough to directly influence the human structures of atoms and DNA. However, it can cause atoms to vibrate, producing heat, and when surrounded by a strong presence of non-ionizing radiation it can be fairly dangerous. The vibration of the atoms causes parts of the human body to rapidly heat up. This may cause injuries such as severe burns. These highly concentrated RF energy levels are found near power types of equipment, and distance transmitters connected to communication towers.

However, the energy levels of RF decrease as it travels through the atmosphere. The further the radio frequency is from its transmitter, the weaker it is. To take precautions against these effects, limiting exposures to the devices and maintaining distance from devices can help shield the absorption of the radiation. Nevertheless, multiple studies have shown the negative effects afflicted from wireless connections on the health of the human body.



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Guardians of Privacy: RSA

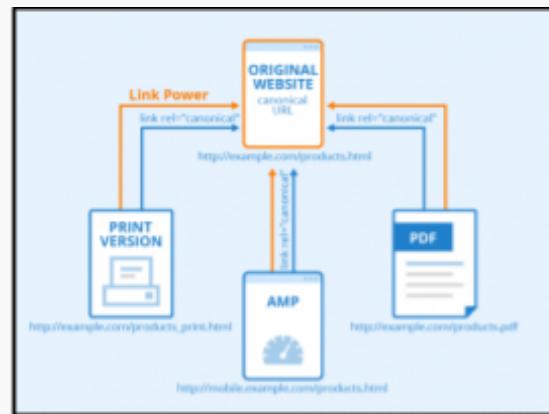
Richard Wang

The ability to securely communicate is important because people don't want their data to be intercepted by random people from around the world. To combat this issue, the data can be encrypted into something that is unreadable by others but readable by the receiver. More specifically, the data is encrypted through an openly shared public key and can only be decrypted through a disclosed private key. This is the essence behind RSA cryptography

RSA, named after its designers, Rivest-Shamir-Adleman, is one of the oldest but still widely used cryptosystems. What makes RSA keys strong is their mathematical basis which involves having to factor the product of two very large prime numbers. As the key numbers become larger, the difficulty grows geometrically.

In the key generation stage, two large prime numbers, p and q, are chosen. Then, their product is computed to get $n = pq$. After that, the Euler's totient function is calculated, $\phi(n) = (p-1)(q-1)$. Next, the public key involves choosing a public exponent, e. The public key ends up being the n product and the exponent (n,e). The private key is found through an exponent d, $de \equiv 1 \pmod{\phi(n)}$. The private key ends up being (n,d).

In the encryption process, the plaintext message is expressed in a number form. How does that work though?



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The way this works is that in reality, messages such as "hello" are made up of a bunch of binary numbers and are encoded with ASCII values. After obtaining the message in number form, the ciphertext, C, is obtained by $C \equiv M^E \pmod{n}$. To decrypt, the original message M can be computed with $M \equiv C^d \pmod{n}$. The backbone of the RSA algorithm is modular arithmetic.

RSA cryptography is a great method for encrypting data that is sensitive. This includes information like credit card details or passwords. Servers use RSA to create a safe channel for transmitting the data. RSA encryption is also used for digital signatures. It isn't used as much for entire messages or files because it is less efficient compared to other encryption options.



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Overall, RSA stands as the foundation for the ability to communicate securely. It is seen in a range of web browsers, email, VPNs, and communication channels to this day.

The Amazing World of Ocean Sound Waves

Riley Lee

The ocean is a huge place full of secrets. A pervasive question about the ocean is what are sound waves. So, where do ocean sound waves come from? Well, there are



"Digital Fire Sound Wave" from Openclipart

natural sounds made by sea animals like whales and shrimp. Even underwater earthquakes and volcanic activity create sound waves. Humans also add sounds through activities like shipping and exploring for oil and gas.

Unlike in the air, where sound travels through moving air molecules, it travels through water molecules in the ocean. Water is denser and doesn't compress easily while allowing sound waves to travel far. The speed of sound in water depends on factors like temperature and saltiness. Warmer and saltier water makes sound travel faster. The ocean's layers also make the sound bend and reflect in different ways. Animals in the ocean use sound waves to talk, find food, and get around. Whales and dolphins are like the rockstars of the sea they use clicks, whistles, and songs to communicate and locate things. Anthropogenic activities such as shipping, naval exercises, and underwater construction create high-intensity sounds that can interrupt marine animals. Human anthropogenic activities can change animals' behavior because big sound waves can be destructive and disturb sea animals.

As sound waves in the water can affect marine actions, humans play a huge part in maintaining control over the sea's peace and balance. In conclusion, the ocean's symphony of sound waves is a dynamic and integral part of marine life.

The Prisoner's Dilemma and Its Impacts on Communication

Spencer Wang

The prisoner's dilemma is a thought experiment used to study cooperation.

Examples of the prisoner dilemma can be seen, almost daily. The issues between Russia and the United States in their arms race is a prime example, as well as Impalas in the hot desert.

The earliest the prisoner's dilemma was conceived, was during the nuclear arms race with America and Russia developing nukes. America had begun to develop nukes, in an attempt to overpower Russia, but Russia had also developed strategies to develop nukes. Game theorists had seen this, and developed, almost a game to be played. Two players must choose to either cooperate or defect from the other. In the case they both cooperate, they both benefit. In the case one defects, the defector benefits, and the other doesn't. If both players choose to defect, nothing is gained. In the case of the arms

race, it was in the best interest to keep their nukes, because the other nation's action could not be ascertained, thereby disabling nukes will put one nation at an immediate disadvantage. Though the nuclear arms race was a simulation of the prisoner's dilemma, that simulation was a demonstration where the prisoner's dilemma was played once. Another demonstration is with impalas in the savanna. The impalas that travel together will see each other every day. This

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group's best interest would be not to defect at every turn, as impalas will be defenseless without other impalas. In this case, with multiple games being played, constant defection will result in zero benefits on either side, whereas cooperation will benefit both parties.



This repeated edition of the prisoner's dilemma is much more prevalent and can reveal much about how species and human parties cooperate. Circling back to the nuclear arms conflict, America and Russia have decided to disable their nuclear firearms slowly, turning the original conflict into a repeated series of prisoner's dilemmas, where both should cooperate.

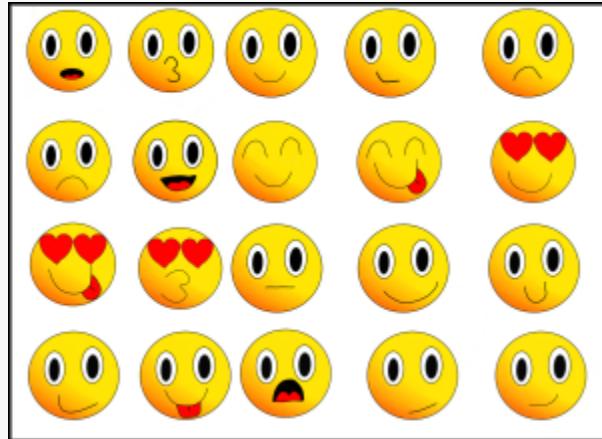
Unveiling the Psychology of Emojis in the Digital Age

Stephen Hung

Emojis, those vibrant little pictograms that have infiltrated our digital communication, are more than just cute add-ons. They're a fascinating window into the human psyche, revealing how we express and interpret emotions in the age of online interaction. But what lies beneath the surface of a grinning face or a broken heart emoji? Let's delve into the science of emojis and explore their impact on our brains, behavior, and relationships.

Emojis bridge the gap between the nuanced world of human emotions and the text-based limitations of digital communication. Studies show that viewing emojis activates the same brain regions associated with processing real facial expressions, suggesting they trigger genuine emotional responses. A simple thumbs-up emoji can evoke feelings of approval, while a teary face can elicit empathy. This emotional shorthand allows us to convey complex feelings quickly and efficiently, adding depth and nuance to our online interactions.

Beyond emotions, emojis can also reveal personality traits. Research suggests that individuals who use more positive emojis tend to be more extroverted and agreeable, while those who favor negative emojis might be more introverted or prone to anxiety. Analyzing emoji usage can even offer insights into mental health, with studies



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showing a correlation between increased use of negative emojis and symptoms of depression.

Not all emojis are created equal. The meaning of an emoji can be influenced by context, cultural background, and even individual preferences. A wink emoji, for example, might be interpreted as playful in one culture but suggestive in another. This ambiguity can lead to misunderstandings and misinterpretations, highlighting the importance of being mindful of the potential for miscommunication when using emojis.



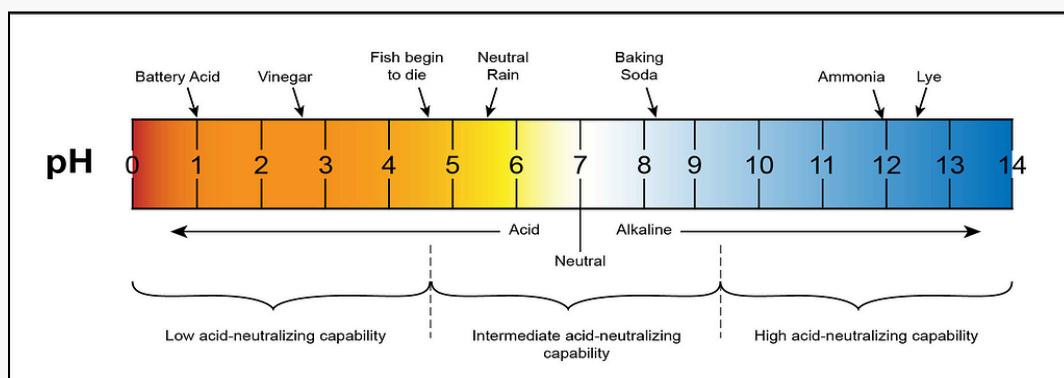
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By understanding their power to evoke emotions, reveal personality, and even influence behavior, we can harness the potential of emojis to create more meaningful and connected online experiences. So next time you reach for a smiley face or a fire emoji, remember you're not just adding a touch of personality, you're engaging in a complex dance of emotions and psychology.

From Acid to Base: The pH Scale

Wilson Zhu

pH, or the potential of hydrogen, is a concept in chemistry that measures the acidity or alkalinity of a solution. It is a scale that uses logarithms that range from 0 to 14; 7 is a neutral value on the scale. Values less than 7 indicate acidity and values more than 7 suggest alkalinity. The pH measurement, which was introduced by a Danish chemist known as S.P. L. Sørensen, represents the concentration of hydrogen ions in a solution, expressed in the equation: $\text{pH} = -\log [\text{H}^+]$. The importance of pH extends beyond the laboratory, as it influences various aspects of daily life.



For instance, pH is vital because it is crucial to maintaining stability, as deviations from the optimal pH levels can lead to health issues. The stomach maintains an acidic pH by using hydrochloric acid, which helps to aid digestion. Additionally, pH is important in agriculture since it influences the quality of soil and the availability of nutrients. Different crops grow better in certain pH ranges, so farmers adjust soil pH to maximize crop yield. Furthermore, pH helps to determine the health of ecosystems; aquatic ecosystems are sensitive to changes in pH levels; acid rain can lower the pH of water bodies, which poses a threat to aquatic life.

Moreover, pH measured with a pH meter translates into pH readings from the difference in electromotive forces. This digital device can provide an advantage in giving more exact results. pH can use different methods for measurement. Litmus paper or other indicator dyes change to different colors that provide a range of pH levels.



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In short, the pH is the measurement of hydrogen ions that illustrate the acidity and alkalinity of a solution. It was first used by the Danish chemist S.P.L. Sørensen using the equation $pH = -\log [H^+]$. The pH measurement system is crucial in numerous subjects, including biology and agriculture.