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SEEKING SCIENCE

by STEM Action Teen Institution

A MONTHLY
STEM NEWSLETTER

HOW BOATS FLOAT

NUCLEAR FUSION

CHAOS AT TWITTER

and more...

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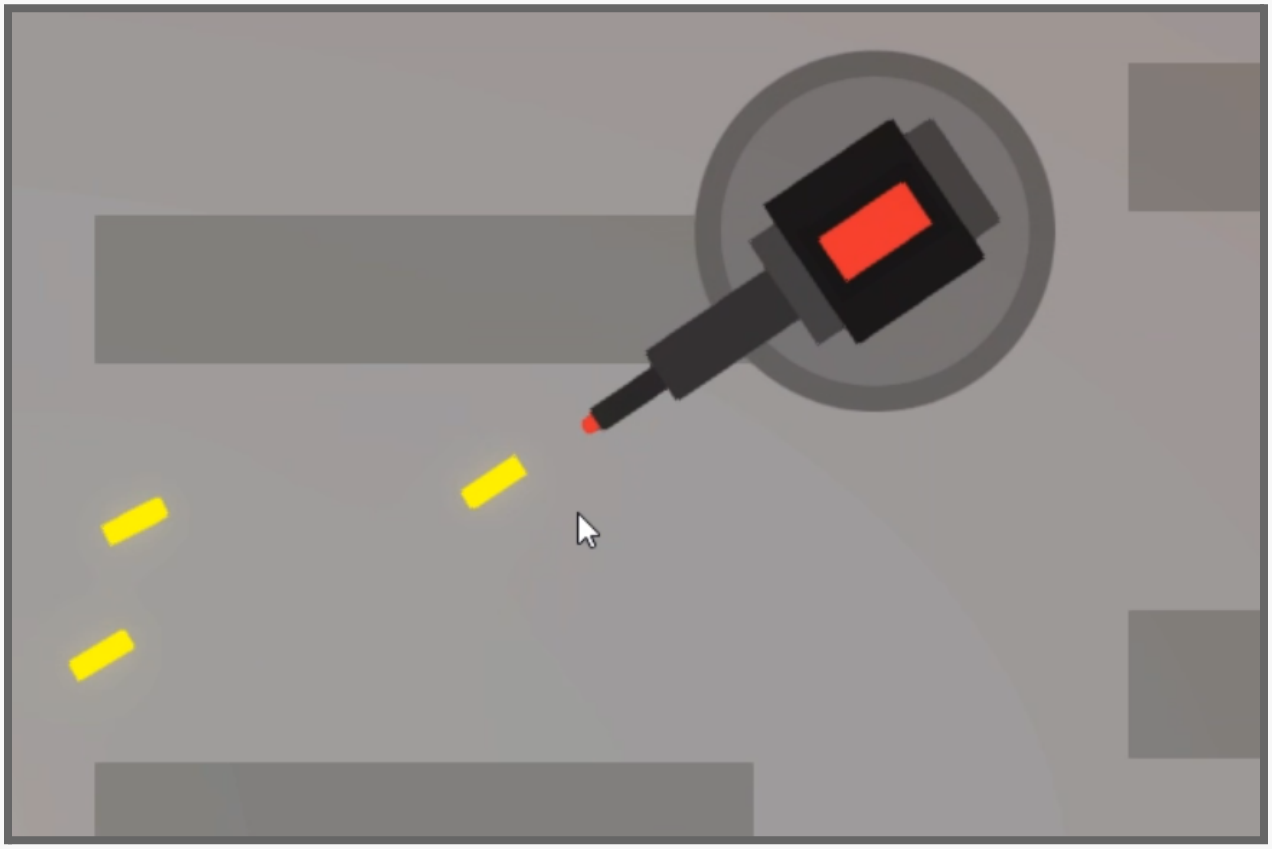
How to Optimize Object Spawning

Ethan Chen

Programs can often put tremendous stress on a computer because they can demand massive amounts of resources that become very costly to keep up with, slowing down performance and leading to loading times or lower framerate. One major culprit of resource usage, one often appears in video games, is the frequent spawning of numerous objects. These objects range from enemies to projectiles to particle effects and props in the environment. They are often complicated objects that consume a lot of computer resources to be spawned, called instantiating, and despawned, called destroying.



There is a better way to instantiate and destroy objects that doesn't allocate precious resources to creating them and then cleaning up their mess after they're destroyed. This method, called object pooling, is an integral part of many classic shooters and bullet hells that make use of hundreds of projectiles being spawned throughout the scene to create a fun and intense action sequence. Instead of spawning objects whenever they are required, numerous objects are instead instantiated while booting up the game, and then they are disabled or otherwise hidden. These objects are then enabled and placed wherever they're needed, and then made invisible or disabled whenever they're no longer needed.

The difference this makes is enormous on performance, especially in cases where objects are spawned tens or hundreds of times per second. The computer no longer needs to spend resources on constantly creating objects, only to destroy them again. Instead, all the objects can be stored in memory and easily accessible from a list in code. Retrieving existing objects from a list is much faster than instantiating them over and over, such as lasers from a spaceship, which is why object pooling has made such a splash in the science of program optimization.

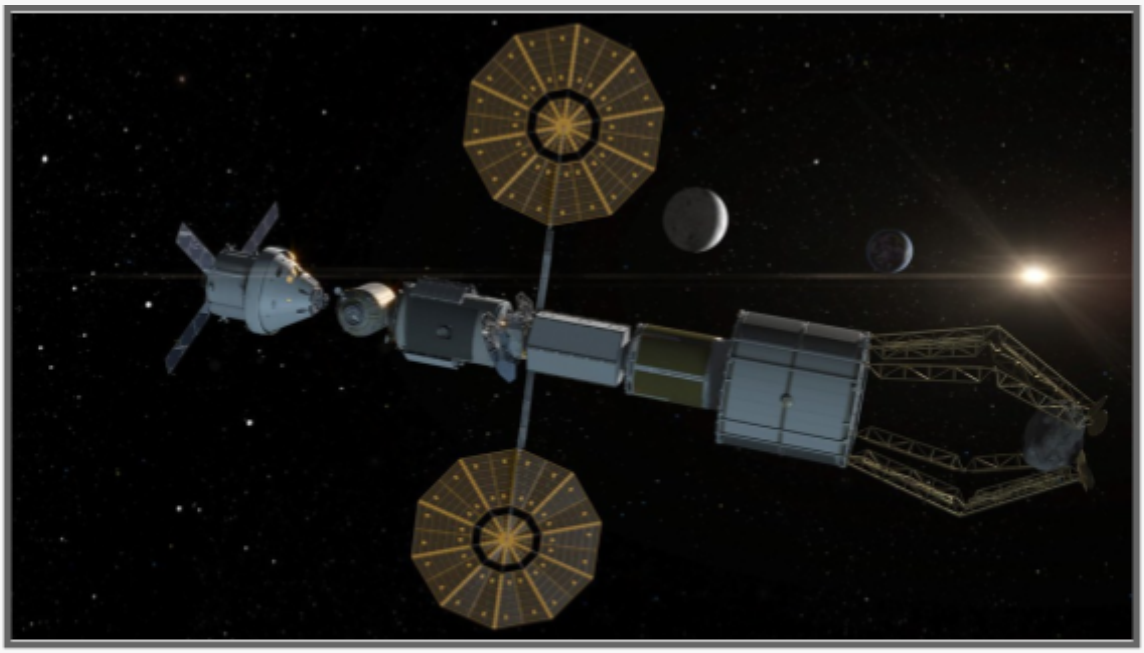
Should Cost Be Considered In Space Exploration?

Stephen Hung

Space exploration is undoubtedly costly, and it will have short-term harm to humanity, but in the grand scheme of things, will lead to their development. Its economic costs are obvious, as "$5.3 billion" was dedicated to NASA for "new spacecraft on their

way to the moon and Mars". These funds come from the pockets of citizens, which will lead to inevitable harm, but these costs will be valuable in the long term, as new technologies will arise from this significant investment. In the past, large amounts of taxpayer dollars have been spent on developing technologies in preparation for the great challenge of sending humans to the Moon, leading to the creation of solar power, water purification systems, and other inventions that greatly improve the lives of many on Earth today.

However, space exploration also poses the risk of endangering humanity through "back contamination," where extraterrestrial organisms are unknowingly brought to Earth. During the exploration of the Moon, people recognized the danger of "infectious extraterrestrial germs" that could have been brought back to Earth. While there was no serious threat, this does not deny the fact that future space exploration could cost many people their livelihoods, if "back contamination" were to take place. Humanity has seen the global spread of microorganisms and the immense tolls it has taken through the COVID-19 pandemic, and if humanity is not careful during space exploration, such a spread could take place once again, with greater consequences.



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Yet, just like how COVID-19 has given scientists and researchers greater insight into biological structures, the spread of extraterrestrial microorganisms on Earth will ultimately give humanity a greater understanding of extraterrestrial life. This could lead to a further understanding of how life could be sustained in space, and overall, how humans could sustainably settle in space, which is something researchers have agreed must take place in the future. Thus, though there are costs that must be considered in space exploration, it will eventually benefit humanity through new technologies and knowledge, which is why the costs involved must be accounted for during space exploration.

Importance of Cyber Force

Owen Chen

The term military is well known to include the air force, navy, and regular land soldiers. But due to rapid development in the cyber interface, military warfare had been shifted towards computer-based, making cyber-attacks became very common. Cyber attacks can vary from data-stealing to corrupting a whole entire network system. In today's world, the cyber interface has a large impact on human lives. It can also change the way someone thinks or acts. Therefore, a nation must have the capability to secure its own data so that the clients can have access to it while the outsiders don't.

In 2009, the United States established a new military branch called the cyber force. Unlike the other military branches, members in the cyber force are trained mentally, dealing with different scenarios organized by the National Security Agency and Central

Security Service using virtual platforms. Once they are done with their training, they are sent to support parts of the military during operations under that specific military general command.

The role of a cyber force is to deal with all conflicts that are involved with cyberspace. This itself is unique, but there are departments that can provide far better aid to all militaries such as the United States Special Operation Commands (SOCOM). Furthermore, the role of cyber force does not have control in any part of the military, while departments like SOCOM exceed the requirements and can aid in any form of operation. However, due to the large number of delicate missions the other departments need to face, the cyber force had been chosen as the better warfare to support all of the military and conduct operations. In addition, intelligence in cyberspace also brings out benefits in controlling the virtual world.

AI of the Underground: Patches and Repairs

Brian Wang

As the digital world is being experienced by many, those who understand the reality behind the presentation given through various interfaces are growing. The websites, applications, and software that look so pretty and easy to use in our day-to-day lives do different mathematical functions humans can't understand from the naked eye. Consequently, it takes hours, or even months, to figure out if there are any vulnerabilities within data systems, leading to those who have the same knowledge capable of dealing large blows to the company. The experts in Imperial's Computational Privacy Group have

created a method called QuerySnout, which can use AI technology to replicate human activities for data breaches, particularly for Query-Based Systems (QBS).

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QuerySnout works by "learning" from questions that are asked and using this data to find any holes within programs. QBS or Query-Based Systems work by providing query data about certain types of information, which helps the system have a "brain," allowing it to exchange valuable information between the client and the server (database). By using a machine learning technique called "Evolutionary Search," QBS is able to ask the right questions in order to pile up a load of knowledge, and then use them to execute the data breach.

How do these machines "learn"? After all, the core mechanism of these methods is based on these machines adapting to certain circumstances. One of the most popular

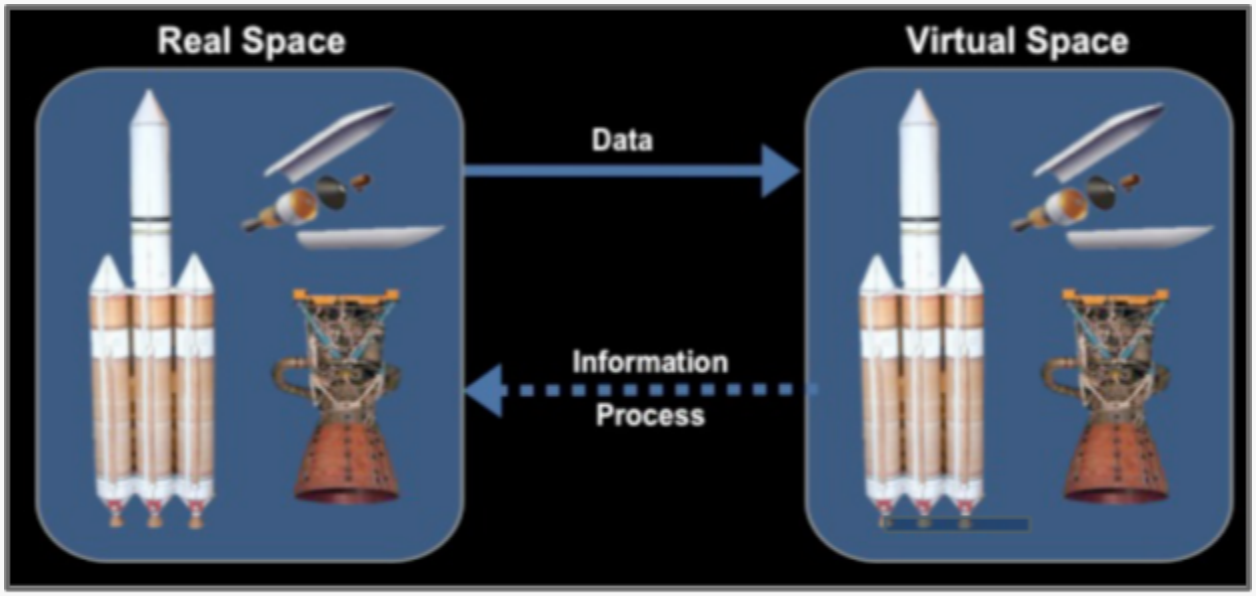
examples of AI learning is Github's Copilot, which uses OpenAI Codex, a descendant of Generative Pre-trained Transformer 3 (GPT-3) in order to work. The reason they work so elegantly is due to them having a dataset of over 150 GB of code from 54 million public GitHub repositories. Through this vast array of knowledge, AI is able to store more and more information about a given topic before outputting an action.

Future of Digital Twins

Richard Wang

Digital twins will be revolutionary for industries and will be the reason for the success of many engineering projects in the future. To understand the plethora of

benefits and real-life applications that digital twins bring, it is essential to understand what digital twins are. Digital twins are accurate virtual models of physical objects. Take a physical object such as an oil drill. Sensors will be used on important components of the oil drill which provides data about the object's production and performance. Data relayed back to a computer or processing system will be implemented into the virtual copy of the object. With this, simulations can be run, allowing for insight into issues and further evaluation of potential improvements.



"Digital Twin Concept of Grieves and Vickers" by Wilmjakob, licensed under Attribution-ShareAlike 4.0 International (CC BY-SA 4.0), https://upload.wikimedia.org/wikipedia/commons/1/1d/Digital_Twin_Concept_of_Grieves_and_Vickers.png

There is an interesting history behind digital twins. An early idea of a digital twin shown was when Nasa used it in the 1960s for space exploration. However, it would not publicly be introduced and invented in 2002 when Micheal Grieves proposed the idea at a SME (society of manufacturing engineering) conference.

The most exciting part of digital twins is how beneficial they can be. It allows for effective research and development. The ample amount of information that is discovered allows for small improvements before further production. The peak efficiency of an item

can be reached and digital twins can monitor the system of production. When a product reaches its end of life, the creators can determine which materials can be collected.

Digital twins are used in many applications and areas of industry. They bring benefits to the automotive industry to increase efficiency and vehicle performance. Electricity generation also sees many benefits as digital twins allow for establishing time frames for the maintenance of large equipment such as windmills. Digital twins are present and act like a guide in all stages of the assembling of a product. Civil engineers can use digital twins to work on municipal projects as well.

Digital twins have an unbound future. They continue to collect information with simulations during the development of the product, thus allowing for maximum efficiency. Also, with expanding technology, we may see many changes to digital twins. The future of digital twins seems to be heading on a positive path.

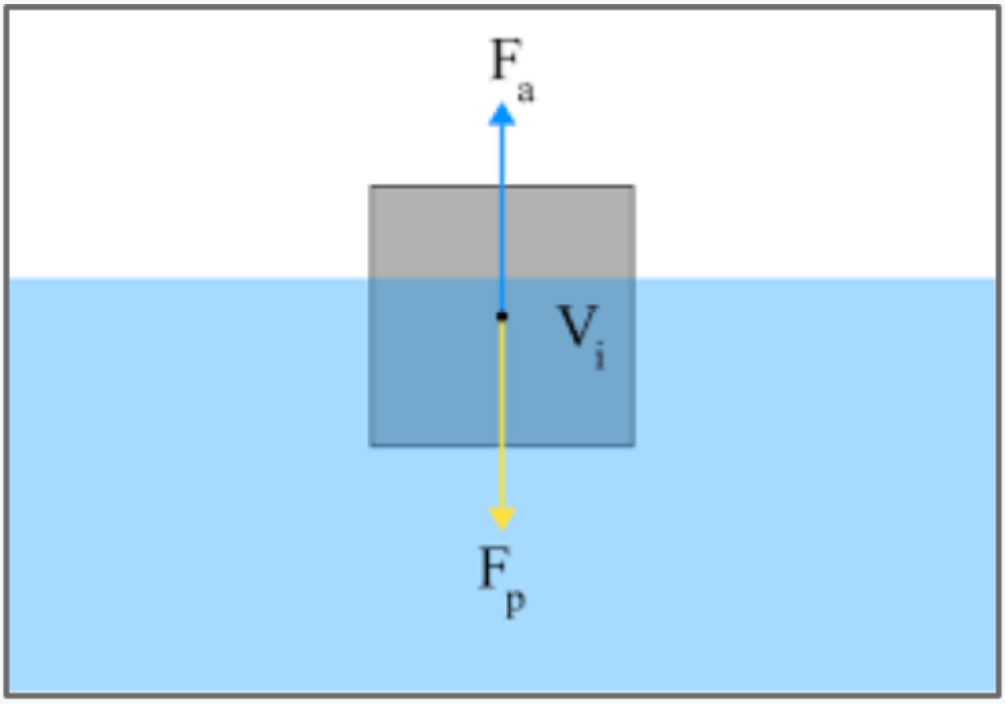
Why Boats Float While Rocks Sink

Aidan Hong

One of the most baffling things is how objects, like cruise ships, float easily, while rocks sink to the bottom instantly. Despite having a weight difference of thousands of tons, the heavier item floats. The answer lies within physics and buoyancy.

While most people know about mass and volume, most people don't realize that density plays a role in buoyancy. Density is how packed the object is, or how hollow it is. An empty water bottle will have a low density, while a full water bottle has a higher density. No matter how heavy an object is, density is always independent of it. Water also has a density, which is 1 kilogram per cubic meter. When it comes to water, the lower the

density, the more it floats, and the higher the density, the more it sinks. Most boats are quite hollow, even with all the passengers and cargo inside. Also, the hull of the ship is very hollow, with only air in it. As a result, the density of a boat is very low, almost close to zero. However, rocks are the complete opposite, with a density of 1600 kilograms per meter cubed! Since 1 is much smaller and 1600, rocks will instantaneously sink to the bottom. However, if there is a hole in a boat, the added weight from the water will cause the boat's density to go up. As a result, after some time, the density will cross 1 kilogram per cubic meter and sink to the bottom.



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Physics plays a large role in our enjoyment of aquatic activities. Thanks to buoyancy, people do not need to worry about their boats sinking, instead just relying on physics to keep their boats afloat.

The Breakdown of Twitter

Aidan Hong

Recently, Elon Musk has taken over Twitter for 44 billion dollars. What happened next was unprecedented, and caused a massive breakdown of one of the most prominent social media apps.

"Elon Musk with Twitter Logo", author unknown, licensed under Attribution-NonCommercial 3.0 United States (CC BY-NC 3.0 US)

On April 14, 2022, Elon Musk attempted to buy Twitter. After legal issues and arguments between both parties, the acquisition was completed on October 27. The first

action he took was laying off a vast amount of their employees, followed by closing their office temporarily. Elon Musk then introduced a new feature, called Twitter Blue, in which anyone could get verified for only $8. Numerous people took advantage of this, and they made parody accounts of real corporations, with all of them being verified. Ironically, both SpaceX and Tesla, which are owned by Elon Musk, were also affected. Elon Musk had to cancel it and suspend all the parody accounts. Elon Musk has also reinstated numerous banned accounts, from political figures to actors.

Since Elon Musk acquired Twitter, Twitter has undergone numerous changes. While some may argue it may change the way Twitter is used, it has undoubtedly caused widespread confusion, significant loss of money, and many people losing their jobs.

The Planetary Defense Mission

Cody Duan

The Double Asteroid Redirection Test, otherwise known as DART, aims to shoot a rocket into an asteroid to alter its path to save the Earth from an asteroid threat. NASA's target was Dimorphos, a minor moon that was not threatening before nor after the test. DART's showcase was to show its capability to defend the Earth in the case of planetary destruction.

The probe was initially launched on November 24, 2021, and after the elapsed time of ten months and two days, on September 26, 2022, they intentionally collided the DART missile with Dimorphous. The crash decreased the moon's total orbit around the asteroid Didymos by 32 minutes. So, the new orbit time for Dimorphos is 11 hours and 33 minutes. This test has been precisely measured to ensure that no consequences appear.

The test has proved the viability of DART, but how does it work? The DART missile uses the energy from the kinetic impact to shift an asteroid's path. Currently, DART has enough power to shift about 5 billion kilograms of mass, but it is still not entirely viable in a real threat. However, it will improve in the hopes that it will protect the Earth from catastrophic accidents.

The European Space Agency (ESA) is in the midst of developing its Hera mission, set to launch in 2024. The Hera mission will conduct detailed assessments of the effects of DART. Members of the Hera and DART team are in the organization AIDA, Asteroid Impact and Deflection Assessment. Although working independently, Hera and DART's combined knowledge will fortify our understanding of asteroids to create a viable system to defend our planet.

The Stanford Prison Experiment

Cathie Zhu

In 1971, Philip Zimbardo, an American psychologist and professor at Stanford University, conducted an experiment labeled The Stanford Prison Experiment. The experiment consisted of creating an incredibly realistic prison environment and placing select volunteers within it, assigning them roles of either prisoner or guard. Zimbardo planned to investigate people's reactions and how readily they would be willing to conform to their assigned roles. He hoped to discover whether the brutality reported among guards in prisons was due to their sadistic personalities or the prison environment they were in.

Zimbardo began by converting the basement of the Stanford University psychology building into a mock prison. Twenty-one male college students were chosen from seventy-five volunteers to participate. They were each screened for psychological normality to ensure a fair experiment with reliable results. Each member was paid fifteen dollars a day to take part in the experiment, which was expected to last for a fortnight.

The experiment was kept as similar to reality as possible, with prisoners getting arrested without warning from their homes. Guards were given a uniform, paired with whistles, handcuffs, and dark glasses. Throughout the experiment, physical violence was prohibited. The prisoners, having arrived at the makeshift prison, were stripped, deloused, and had their personal possessions confiscated. They were issued an identification number and referred to by those numbers only. In total, there were three guards to the nine prisoners.

Very quickly, both the guards and prisoners were settling into their roles. Guards began to harass prisoners, acting brutally and sadistically, even enjoying it. The prisoners were often insulted and given petty orders, getting dehumanized by the guards. Similarly, prisoners began to adapt to their new roles. They would 'tattle' on other prisoners and take the prison rules very seriously.

Thirty-six hours later, a prisoner had to be released due to uncontrollable bursts of screaming, crying, and anger. It seemed as though he began to enter the early stages of deep depression. Within the next few days, three others were pulled from the experiment due to signs of emotional disorder and instability that may have lasting effects, despite all participants being pronounced stable before. Zimbardo shut the experiment down after six days rather than letting it continue for a fortnight.

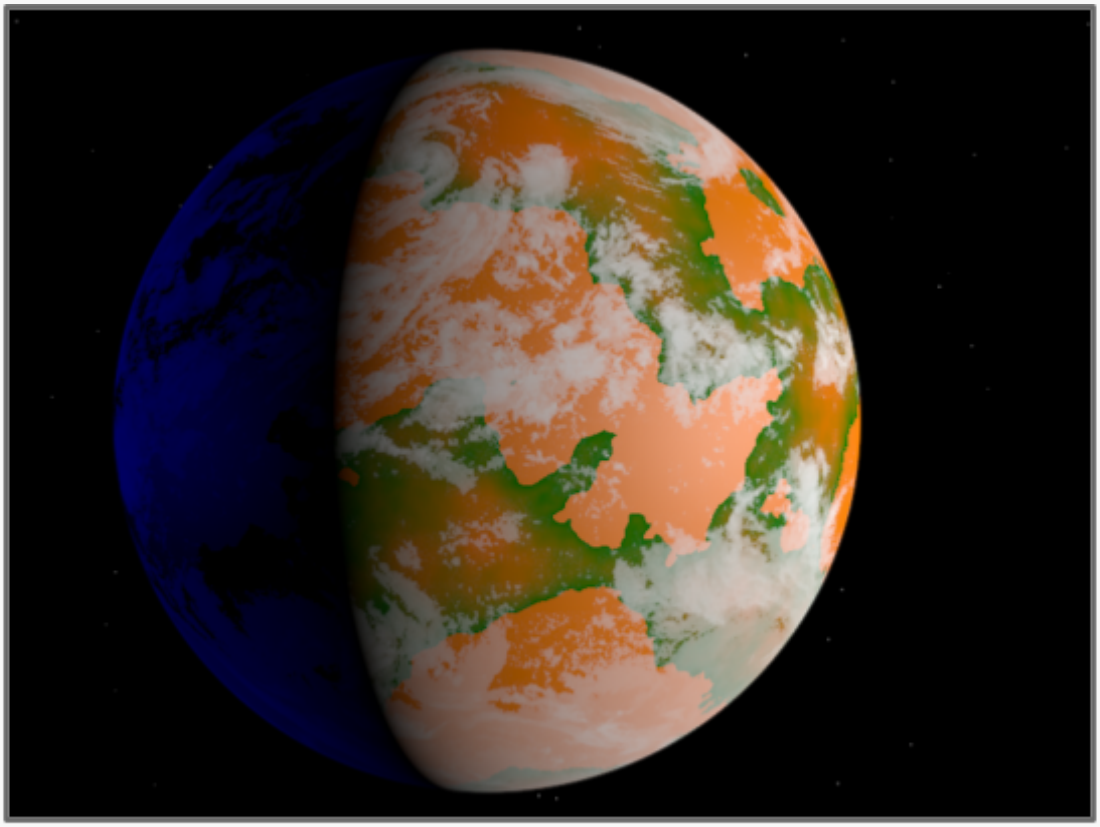
The environment they were in proved to be a crucial factor in the participants' behaviors, showing that the environment as well as a person's role can shape their behavior and attitudes. Soon after the experiment was terminated, the participants were interviewed. Most guards found it difficult to believe how they had acted during the experiment. They stated that they were unaware that this brutal side of them existed or that they were capable of performing such actions. Similarly, prisoners were baffled by how they responded so yieldingly. It was concluded by Zimbardo that people will readily conform to the societal roles they are expected to play, especially those that are strongly stereotyped.

An Unpolished Planet

Anna Dai

We know that planets are made of mineral rocks and some are made of gasses and liquids. As terrestrial planets, Earth is made up of solid basalt and granite and Mars is made of iron, nickel, and sulfur. However, a gemlike planet, made up of actual diamonds, is only 40 light years away from Earth.

In 2004, astronomers discovered 55 Cancri E that orbits Copernicus, a G-type star similar to the Sun. This "diamond" planet is located in the northern part of the Cancer constellation, which is mainly composed of carbon graphite, iron, and silicon carbide. With its size being twice as much as Earth's, the 55 Cancri E is worth at least 26.9 nonillion dollars!



"55 Cancri e", by PlanetUser, licensed under Attribution-ShareAlike 4.0 International (CC BY-SA 4.0)
, https://commons.wikimedia.org/wiki/File:55_Cancri_e.png

How is 55 Cancri E actually made up of diamonds? This planet has a substantial amount of carbon and because the distance from the planet to its host sun is not far, the carbon-to-oxygen ratio is higher. However, recent studies show that the planet's host star may not be as carbon-rich as everyone thought it was. This makes the ratio Researcher Johanna Teske has analyzed the so-called "super-Earth" and stated that "In theory, 55 Cancri e could still have a high carbon-to-oxygen ratio and be a diamond planet, but the

host star does not have such a high ratio." So, the information used to propose the idea of 55 Cancri E to be made of diamonds is not valid.

As of now, the data we have on this uncommon exoplanet is unable to completely verify the planet's bright identity. Humans are incapable of traveling to the planet to try to dig up diamonds so we can only rely on the knowledge we have on this unique planet.

The Science Behind Clocks

Edward Huang

Despite serving a simple, singular function, clocks and other time-telling devices demonstrate that something that seems simple can actually contain a mountain of science behind it. All clocks, analog and digital, must be able to send a signal at a regular, periodic interval, and they must be able to do so for long periods of time. Because of this, clocks must be precise and stable. There are multiple different ways that clocks achieve this.

"Roman-numeral-number-IIII-watches-clocks-11" by Yann Caradec, licensed under Attribution - Non Commercial Use - Share Alike 2.0 Generic (CC BY-NC-SA 2.0)
https://monochrome-watches.com/why-do-clocks-and-watches-use-roman-numeral-iiii-instead-of-iv/#image-gallery-10

The first modern clocks were theorized by Galileo Galilei. He noticed that a pendulum would always take the same amount of time to make one full swing. Even with air resistance, which slowly absorbs the kinetic energy of the pendulum, the pendulum will always swing with the same amount of time, despite becoming lower and lower. Galileo realized that this fact could be used to design an effective clock. Later, Christiaan Huygens would take Galileo's ideas and implement them into reality by building the first pendulum clock. This clock involves a pendulum regularly releasing an escape wheel, which pushes against other gears and regularly rotates the hands of the display. The concept of an escape wheel, or escapement, would be crucial to other modern clocks, as it is the component that converts the oscillating release of energy into the motion of gears, which eventually spins the hands of the clock. The clock is optimized to lose as little energy as possible, so that its rhythm is as stable as it can be. But, infinite motion machines are not possible, because energy will always be lost, no matter how slow. So, the clock will reach a point where it will start to get slower and eventually stop.

Many modern analog clocks usually involve a wind-up spring to store energy and slowly release it. The energy supply to these kinds of clocks is the hands of a person, who inserts a key into the clock in order to wind up the spring. The spring slowly releases energy, and an escapement, which slowly absorbs and releases the energy from the mainspring, converting it into the motion of gears. The release and hit of the escape wheel's gears is usually responsible for the "tick tock" sound usually associated with clocks. Unlike pendulums, this clock design is unaffected by movement and does not require an unmoving environment. Mainsprings are very useful in watches, where even regular hand motions will not disturb its periodic motion.

Some analog clocks do not rely on a pendulum or a swing, but instead rely on quartz crystals that pulse at regular time intervals that can be read using small microcircuits. Quartz crystals are able to oscillate at regular frequencies due to the

piezoelectric effect. Under mechanical stress, many crystals will slightly build up electric charge. The reverse is also true, where when crystals are given a voltage, they will vibrate at a certain frequency. In quartz clocks, a current is passed through a quartz crystal, causing it to vibrate at a frequency, which is typically 32,768 times per second. Being a power of 2, this input can easily be read by a simple circuit involving a chain of 15 “flip-flops”. Each flip flop divides the input frequency by 2, so that by the end of the circuit, the circuit outputs once per second. Escapements are unneeded in quartz analog clocks, since a motor can be wired to the circuit to spin the gears. The power source is in the form of a battery. Despite using electric circuits, these clocks are still considered “analog” due to the non-digital method of displaying the time, through the use of hands.

Digital clocks also use quartz crystal oscillations, except they use an LED display instead of hands. A microchip is used along with the quartz crystal to convert binary numbers into 7-segment display numbers. The microchip can keep track of the current time in binary, and display it on the LED screen. While more accurate than pendulums and springs, quartz oscillators are not flawless. Like pendulums, they also become less accurate over time. Quartz crystals can “age”, and their vibrations can slowly decrease over time, due to repeated stress, moisture, and high temperatures. Some clocks can bypass this by using pre-aged quartz crystals, which are already aged to the point where they essentially stop aging, since quartz crystal ages at a logarithmic rate.

"Patek Philippe & Hewlett Packard Atomic Clock (circa 1960s) - Geneva time. #NOLA - M.S. Rau Antiques (taken on 2015-03-26 21.11.11 by @DrGarcia)
" by @DrGarcia from in motion, licensed under Attribution-ShareAlike 2.0 Generic (CC BY-SA 2.0)
,https://commons.wikimedia.org/wiki/File:Patek_Philippe_%26_Hewlett_Packard_Atomic_Clock_%28circa_1960s%29_-_Geneva_time._%EF%BC%83NOLA_-_M.S._Rau_Antiques_%28taken_on_2015-03-26_21.11.11_by_@DrGarcia%29.jpg

By far the most accurate clock is the atomic clock, a clock that relies on the resonant frequency of atoms, specifically Caesium-133 atoms. These atoms contain electrons that alternate between different energy levels, where these transitions between energy levels release electromagnetic radiation at a certain frequency. More specifically, these atoms resonate at exactly 9,192,631,770 Hz. In fact, the very definition of the second is exactly the period it takes for a caesium-133 atom to vibrate 9,192,631,770 times. In these clocks, caesium atoms are heated into one energy state and travel through a tube. Inside this tube, the atoms are then irradiated by microwaves, to convert them to their next energy state. Occasionally, some atoms fail to reach the next state, so they are filtered and removed using a magnetic field. A detector counts the number of caesium atoms that reach the end of the tunnel, which is maximized when the microwave is tuned at the optimal frequency. There is a specific frequency for the

microwave for the maximum amount of caesium atoms to be counted, which is 9,192,631,770 Hz. Despite being extremely accurate, many researchers are developing new technology to create an even better clock.

The pioneer of clock technology is the optical clock. While still being researched to this day, optical clocks are predicted to surpass atomic clocks in their precision. They act very similar to atomic clocks, but they use light waves instead of microwaves. These more accurate clocks will hopefully be used in satellites and space-probes in order to accurately calculate their position.

Though they may serve a very simple function, clocks are surprisingly complicated and engineered. From Galileo's pendulum to the modern optical clock, the evolution of clocks demonstrates the application of science and engineering in the most fundamental purpose: telling time. But, it has also shown that clocks are never perfect, and both researchers and engineers are continually improving old designs and building better, more accurate clocks.

The Space Race

Wilson Zhu

After World War II, a new conflict, named the Cold War, was occurring between the United States and the Soviet Union. In the late 1950s, racing to space became another competition that would show which side had superior technology. There were many causes for this race to start since there were many tensions caused by the threat of nuclear weapons. Firstly, in 1957, a Soviet missile launched Sputnik which was the first man-made satellite ever placed into the Earth's orbit. This was an unpleasant surprise for the Americans. The Americans understood that exploring space was seen as the next

logical move and that it is crucial that they should not be behind.

"APOLLO-SOYUZ TEST PROJECT (ASTP) (DOCKING) - ART CONCEPT" by NASA, licensed under Public Domain Mark 1.0
https://picryl.com/media/apollo-soyuz-test-project-astp-docking-art-concept-8c8201

In 1958, the United States launched Explorer I, also in the same year, President Eisenhower also created the National Aeronautics and Space Administration (NASA) for space exploration. In 1961, Soviet cosmonaut Yuri Gagarin became the first person to orbit Earth while traveling in the Vostok 1. Also, President John F. Kennedy claimed that the United States would be able to land a man on the moon before the end of the decade and launched Project Apollo. From 1961 to 1964, the budget of NASA increased tremendously and the lunar landing program involved thousands of employees. But in 1967, the Apollo mission faced a problem where three astronauts were killed after their spacecraft caught on fire during the launch. In 1968, the launch of Apollo 8 was the first manned mission to orbit the moon.

Finally, on July 16, 1969, American astronauts Neil Armstrong, Buzz Aldrin, and Michael Collins were all set for the Apollo 11 lunar landing. They were able to successfully land on July 20 and Armstrong became the first man to ever walk on the moon. After they landed on the moon, the space race ended with the Americans winning. After the

space race, many missions diminished. Ultimately, the space race led to great technological advancement in astronomy which also led to more study of astronomy in the future.

How Bad is Climate Change?

Riley Lee

Climate change has been evolving around everyone for the past 800,000 years, but how bad is climate change? Climate change has become extremely bad that it causes more frequent and intense storms, heat waves, droughts, warming oceans, rising sea level, and melting glaciers. The more these events happen the more animals get harmed with the places they live in getting destroyed. Climate change is the largest most pervasive threat to the natural environment and societies the world has ever experienced.

Climate change is getting worse every year as we speak. Some ways we can stop or slow down climate change is by walking or biking more often, switching to an electric vehicle, reducing, recycling, or reusing. If we manage to stop climate change it would still take a few years for the global temperature to flatten out. It will lower the chances of animals being extinct as we slow climate change down.

"Why-Adapt_Impacts-of-climate-change_Bushfires_HERO-2_Bushfires2_Image_2x1", by Michele Cooper/DPIE, licensed under Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) ,https://nuscimagazine.com/the-materialism-of-climate-change-exploring-ancient-philosophys-impact-on-climate-change/

Climate change is a dangerous effect on our environment that we are facing these days. If we don't stop or try to stop climate change there will be an estimate of 170 percent increase in floods, wildfires, and natural events. There will also be more than a third mass species extinction in the future if climate change keeps happening.

If we stop climate change completely, animals and plants would be safer and healthier on Earth. Therefore, climate change is very awful because climate change destroys animals and nature and we need to try to stop it.

Bullet Trains vs Hyperloop

Denise Lee

All over the world, new inventions and ideas have been brought up to improve transportation. Bullet trains are rail systems that can handle speeds above 330 kilometers per hour and are also the fastest and most efficient land vehicles known to mankind. The bullet train works on the principle of magnetic levitation and magnetically guided steering. Elon Musk, CEO of Tesla, and founder of The Boring Company proposed the idea known as the hyperloop. The hyperloop is a high-speed transportation that uses magnetic levitation and is also powered by magnetism. It uses a pod that is pressurized at atmospheric pressure, traveling in a large tube with no air resistance or friction. Both the bullet train and the hyperloop use magnetic levitation, but what are their differences?

"Shinkansen JR500 Series", by Caribb, licensed under Attribution-NonCommercial-NoDerivs 2.0 Generic (CC BY-NC-ND 2.0) , https://www.flickr.com/photos/caribb/3935893306

The main difference between the hyperloop and the bullet train is how fast the hyperloop is compared to the bullet train. According to the Business Insider's video, "How Elon Musk's 700 MPH Hyperloop Concept Could Become The Fastest Way To Travel" the narrator says, "This is the future of high-speed transportation. It's 3 1/2 times faster than Japan's Shinkansen bullet trains and even faster than a Boeing 747. It's a hyperloop – magnetic pods levitating inside a tube at more than 1,000 kilometers per hour. In theory, you could go from LA to San Francisco in just 45 minutes" (0:00).

The hyperloop maintains its speed as if it was in outer space. Though the hyperloop uses minimal energy requirements to accelerate the pod, it has many energy requirements. The hyperloop uses much energy as it needs to maintain a near vacuum inside the miles of the tubing by running several air pumps. Bullet trains need a lot of power to maintain their speeds against the air drag throughout the track which makes it less energy efficient than the hyperloop. Hyperloop costs 20 billion dollars to make while bullet trains cost 17 billion to make. To conclude, the hyperloop is 3.5 times faster than the bullet train, it's more efficient, and it costs more than the bullet train.

Cooking Fuel From Coconuts

Eason Fan

According to Climate Central, an estimated 3 million people die from air pollution or other effects of burning up wood. This number is expected to rise as more pollution gets into our atmosphere heating up climate change. A small company called "Rugsal Trading" tries replacing cooking wood with a mixture made from coconut shells.

Wood chopping is a huge issue faced by many developing countries. The lack of trees means more CO2 in our atmosphere and fewer roots holding our soil. As climate change is rapidly getting severer, more catastrophic weather events take place. Without trees holding the soil, mudslides will increase.

The founder, Alhaji Siraj Bah spent years creating a cooking fuel made from waste after losing his family in a mudslide. The area that he lives in saw devastating decreases in trees and unprecedented numbers of natural disasters. He was determined to alleviate the need for wood and work toward a more sustainable future.

"Deforestation in Sierra Leone", by jbdodane, licensed under Attribution-NonCommercial 2.0 Generic (CC BY-NC 2.0) https://www.flickr.com/photos/jbdodane/9303470906

The company would haul leftover coconut shells from the local market to a factory. Then, it is cleaned and set outside to be dried. After about a week, the coconuts would end up in a large steel drum, to be cooked. In 3 to 4 hours, they would extinguish the shells with water and wait for them to dry again. Next, the cooked coconut gets turned into a powder and is mixed with water and a couple of other ingredients. A machine then turns the mixture into rectangles to be dried for 3 days. Finally, it will be packaged or made into different products.

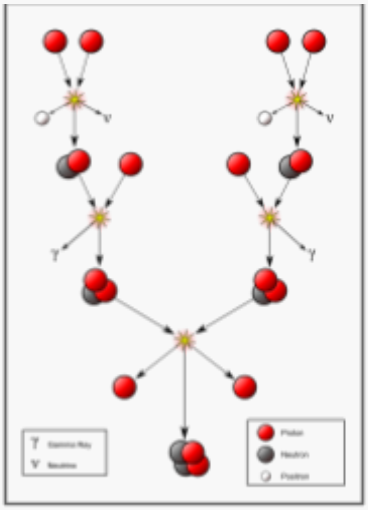
Their products range from briquettes to cooking fuel and also expanded to the chicken industry. These high-quality products are found in almost every local supermarket. The briquettes are among the most popular in town. Alhaji hopes to do the same with his cooking fuel by getting more people aware of the environment.

Alhaji won multiple awards for his idea gaining overseas customers. He hopes to grow the processing capacity to 5 times as much by the end of the year. The future is certain, it is one with our environment in mind.

The Nuclear Fusion Reactor

Arthur Liang

Nuclear fusion is the process that occurs at the centers of stars. Lighter cores release a burst of energy when they fuse into heavier cores. For fusion on Earth, deuterium and tritium are heated to extreme temperatures. The gas becomes plasma, and nuclei reassemble, forming helium nuclei and neutrons. By igniting millions of reactions per second, fusion can produce huge amounts of energy from very tiny amounts of fuel. To control these very hot plasmas, scientists use extremely strong magnets.



"Fusion in the Sun", by Wikimedia, licensed under CC BY-SA 3.0
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The advantages of fusion energy are numerous and make fusion appear a very possible option. The waste product of the fusion reaction is a small dose of helium that can be released without significant environmental damage. Deuterium and tritium can be made abundantly from things as common as seawater, allowing these fuel supplies to last thousands of years.

There is no radioactive waste that comes from fusion reactions. Only reactor components become radioactive. A nuclear accident cannot occur in a nuclear fusion reactor unlike in a nuclear power plant. Because the fusion process is hard to maintain,

this can provide a benefit as there is no danger of a chain reaction leading to a meltdown. After fusion reactors become commercially viable, the cost should be about the same as other energy sources. Fusion could be our source of clean and free energy in the future and lead to new pathways for humanity.

Cell Division - Root of Life

Eddie Zhang

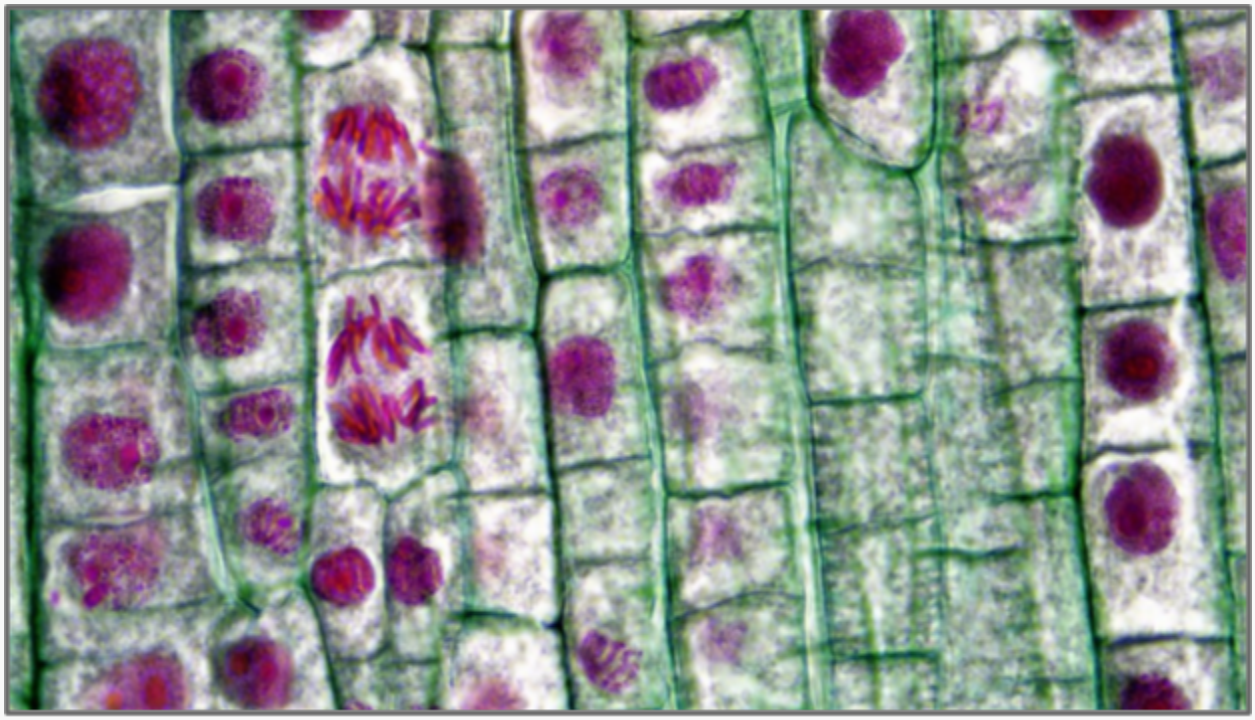
Have you ever thought about why your injuries heal? Or about how seeds transform into plants? Well, it's thanks to the process of cell division, the basis for life.

All living organisms are composed of cells. There exist unicellular organisms, like bacteria, and multicellular organisms, like humans. These cells form structures, like our skin, organs, etc, which maintain life. However, cells can be destroyed naturally or by injury, which is why cell division is essential.

Cell division is the process where a cell copies itself and splits in two. This is how wounds heal, cells rapidly divide, filling the gap in the skin. It is also how we are born, as humans start out as a single cell. This process of splitting–called mitosis–is divided into four stages, prophase, metaphase, anaphase, and telophase.

In prophase, the cell duplicates its DNA–in the condensed form of chromosomes–and organelles, which are essential for cell survival. After duplication, the chromosomes are composed of two sister chromatids, connected in the middle (kinetochore). In metaphase, the chromosomes line up in the middle of the cell as spindle fibers are created from the centrioles (organelles) that latch onto the kinetochores. In anaphase,

the spindle fibers pull the sister chromatids apart, heading in opposite directions. Finally, in telophase, the cell membrane splits, forming a brand-new cell.



"Mitotic Stages in Apical Meristem of Allium Root Tip" by Berkshire Community College, licensed under CC0 1.0 Universal (CC0 1.0) Public Domain Dedication, https://www.flickr.com/photos/146824358@N03/37385550196

Mitosis, however, is not flawless. Errors during replication are possible, which may lead to cell death or disorders. Sometimes these mistakes–called mutations– are benign, but other times, they can be deadly. The most notable example is cancer (when cells don't stop dividing), which is difficult to treat as it is not a foreign body.

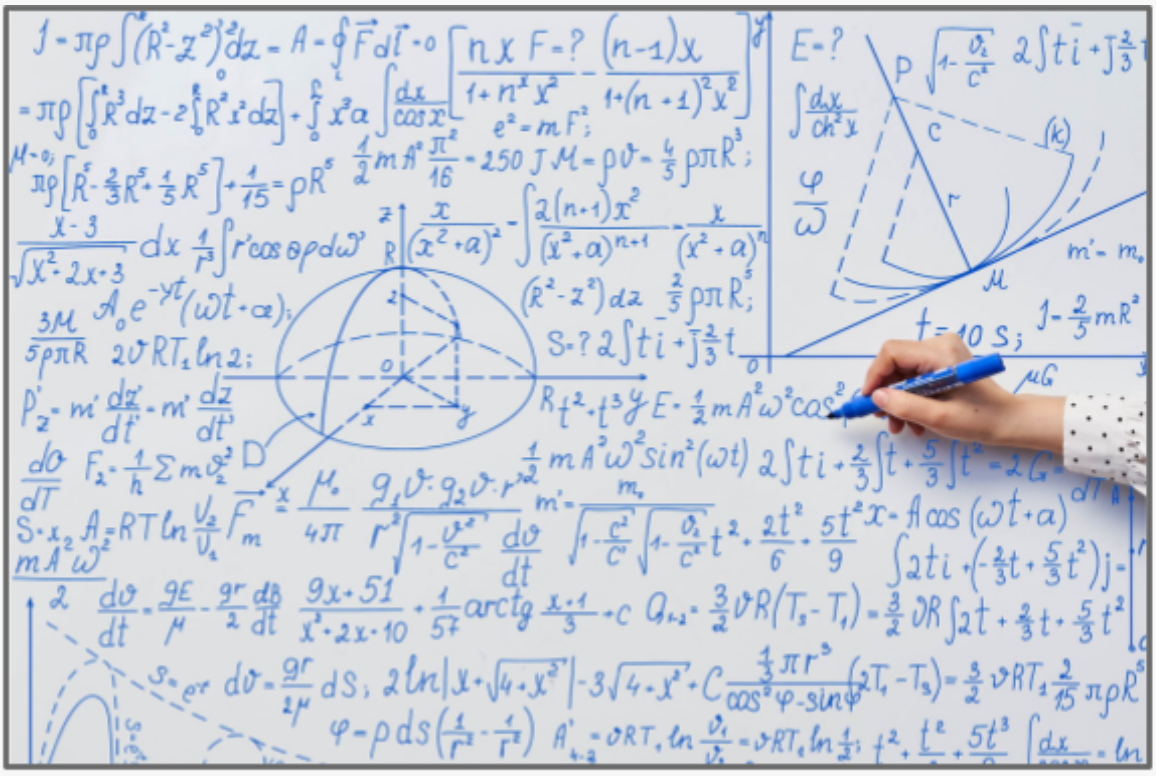
Yet, despite this, mitosis is indispensable to all life on earth, and we will have to cope with any mistakes it makes.

MATH in Daily Life

Donia Cao

Mathematics is a common subject that is studied. It is used in daily life. The basics of it are required. All work is always linked to math in some way.

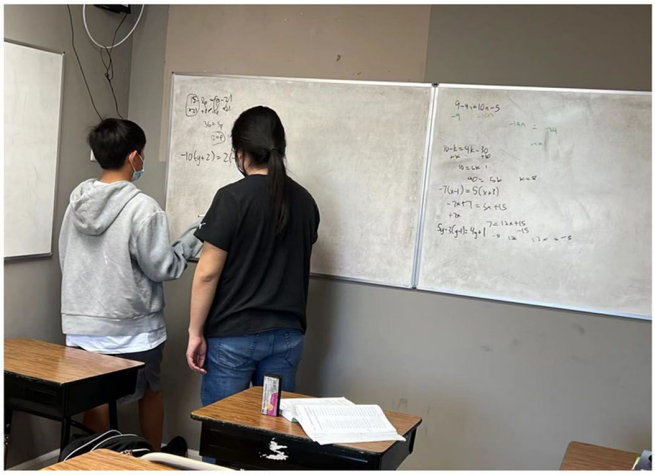
Mathematics can be divided into two parts: pure mathematics and applied mathematics. In Pure mathematics, we need to study the basic concepts and structures of math. Pure mathematics discovers the border between mathematics and reason. It is sometimes described as part of mathematical activity. Applied mathematics involves the application of mathematics to solve problems that arise. Applied mathematics is the application of mathematical methods in different fields. So, applied mathematics is a combined form of mathematical science and specialized knowledge.



"Teacher's hand writing complicated mathematical formulas on the whiteboard", by Marco Verch Professional Photographer, licensed under Attribution 2.0 Generic (CC BY 2.0), https://www.flickr.com/photos/30478819@N08/51093180622

Math makes life ordered, and every creation involves math. Every career involves math. Our modern-day world runs on computers, and computers also run with the help of math. Every growth that happens requires math.

Mathematics has a wide variety of uses in our daily life. Math usually deals with numbers. There are various subjects in math. Math is used to find the relation between two numbers. Math includes a diverse amount of numbers and many symbols.



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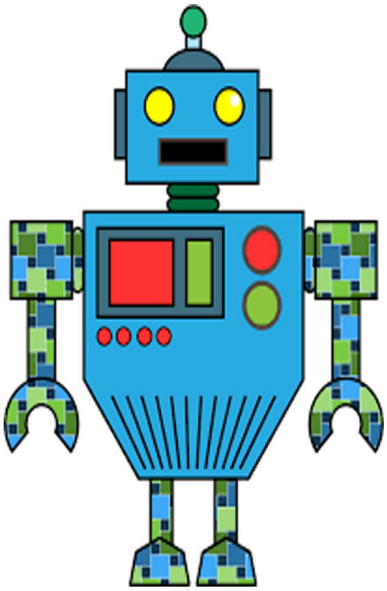

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