FINALISTS MAGAZINE 2023

#700STEMChallenge

Forge your own path

INTRODUCTION

Congratulations to the finalists of the sixth Sydenham High's #700STEMChallenge.

There were so many amazing entries, all of an extremely high standard. After much deliberation, the following articles were selected as the top entries for each category.

Annabelle Simmonds, creator of the Challenge in 2018 whilst in Year 12 at Sydenham High.Currently completing an apprenticeship with Ernst & Young.

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Please note that submitted essays were not considered for the finalist selection if they did not meet the set criteria, or calibre expected, so on occasion there are fewer than three finalists.

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SCIENCE ESSAYS
Under 14

Why do we dream?

Aanya Sharma, Wimbledon High School

Dreams are something everyone experiences, whether you remember them or not. They may often seem random, or nonsensical, but for centuries, scientists, psychologists and ordinary people have been trying to find out why we have evolved to dream, and what our dreams mean. A bit of background: most of our dreams occur during the REM cycle [1], which is when our brains are most active, almost as much as when we are awake, and we will be in a state of REM sleep around 3-5 times every night [2]. We do not always remember our dreams because the Hippocampus does not store as much information as usual when we are in REM sleep [3]. This makes it very hard to analyse dreams and find out why they happen. I will be presenting some of the theories about why we dream in this essay.

The newest theory about dreams is the 'Overfitted Brain Hypothesis' (OBH), invented by Dr Erik Hoel, who published a paper on his theory in 2021 [4]. Dr Hoel argues that dreams must have an evolutionary purpose because of how many animals dream, and because dream deprivation has been proven to be damaging in animals. He writes that the brain is always in danger of 'overfitting', which is when animals (including humans) do not have generalizability – meaning they cannot apply their knowledge to a broad range of situations, because their 'dataset' or experiences are too narrow. His theory is that dreams add variety to this 'dataset', helping the animal or person 'think outside the box' and learn how to problem solve in situations they are not prepared for. This theory is backed up by the concept of using corrupted data sets in machine learning, to train the machine to prioritise and filter data, which is a widely used method, and proven to work.

Before this theory, the most widely accepted hypothesis was Sigmund Freud's theory, from the 1920s [5]. He said that dreams are a method of wish fulfilment, and are the only time when the Id (subconscious) is unrestricted by the Superego (moral compass), which usually favours the Ego (conscious) [6]. He said that the Id was the impulsive part of the brain, and the part you are born with, which is why children often fight for what they want. His theory was that wants became wishes when they are denied. He formed this theory based off an incident when his young daughter, Anna Freud, was told that her illness was caused by strawberries, and was later heard talking in her sleep about eating strawberries. He says that this is because she loved strawberries, but was told to stop eating them, leading her want to become a wish, and therefore, a dream. Freud's theory can also explain why humans enjoy other fictions, like novels and films, but it is not backed up by scientific evidence.

Contrary to both these theories, some scientists believe the 'Null Theory' [7]. This is the belief that dreams have no evolutionary purpose, and that they are simply epiphenomena (or mental by-products) of REM sleep, which is beneficial. This hypothesis used to be commonly accepted, but has since been overshadowed by more recent theories, as there is much evidence against it, such as how the Romans linked dreaming to learning, even when they thought that dreams were messages sent by the Gods [8].

In summary, many theories of why we dream have been formed. The oldest theories were mostly speculative, while the more recent theories are based off new evidence and technology. The 'Null Theory' suggests that dreams are a by-product of evolution and sleep, Freud's theory concluded that dreams are the unrestricted subconscious, and the 'Overfitted Brain Hypothesis' says that dreams widen our brains' 'datasets' to aid problem solving and learning. All these theories can also be applied to why humans are interested in reading fiction, watching films, and playing games. However, none of them can be conclusively proven until we have better technology to examine the brain with. The 'Neurotech' industry is growing [9], meaning that more research is being done in this area, and more investment is being given to start-up businesses who are trying to answer this question. It is very likely that more will be discovered about why we dream in the near future, but this essay has examined 3 of the main theories, for now.

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Do immortal jellyfish really live forever?

Rosa Lambert, Sydenham High School

Is it possible to live forever? You probably don't think it is. The human life expectancy is 73 years, so surely it isn't possible to live much longer than that? Well, if that's what you think, you're wrong! There are some creatures that can actually defy death. This is rare, but some mind blowing animals could possibly survive for thousands, even millions, of years.

Immortal jellyfish (also called turritopsis dohrnii or T. dohrnii) are an amazing type of jellyfish that can unbelievably reverse their age. If in danger, they can reabsorb their tentacles, meaning they don't have the ability to swim. They then sink to the seafloor and throughout the next day and a half they turn into a polyp. This means it is returning to an earlier stage of its life cycle. According to Two Oceans Aquarium, 'In the polyp phase, the jelly closely resembles its cousins, the sea anemones,'. The polyp will then turn into a mature jellyfish. Surprisingly, this process only takes around 48 hours to complete!

As I have already said, this incredible jellyfish will use this superpower if it is in danger. For example, if it is starving or injured or being hunted by predators it will instinctively revert to a previous stage of its life. It can repeat the process infinite times…which means that the immortal jellyfish could theoretically live forever.

The immortal jellyfish were discovered in 1883, but who knows how old the oldest living one is. They have been around since the dinosaurs (some of their fossils are 500 million years old), so there might, conceivably, be one who has been around all that time!

However, despite their awe-inspiring name and the fact that they can defy death by reverting to an earlier stage in their existence, can they really live forever? The word immortal implies that a living creature actually cannot die. But is this true of these creatures? The answer is, no. Well, not entirely. Although they can reverse their age, they can still die. They can still be killed by predators such as sharks, turtles, fish (they are only about 4.5 millimetres so can easily be eaten by predatory sea creatures) and also other jellyfish. They can also starve or get sick, which can cause death, if the conditions they need to regenerate are not perfect.

This means that they are technically not immortal, as being immortal means never dying, so their name can be misleading.

So although they can reverse their age to escape death, their method is not foolproof. If they were truly immortal, nothing could kill them, no predators, no diseases, nothing.

Therefore, their name is not truthful. Although it is possible that there could be some who have survived since the dinosaurs, it is highly unlikely.

Moreover, when they return to polyp form, they are especially vulnerable and can do hardly anything to protect themselves. The fact that they can die as a polyp and as a mature jellyfish clearly proves that they should not be known as immortal.

Having said all that, the immortal jellyfish actually might have a lot to teach us about survival, even if they can't live quite as long as their name suggests. In September 2022, the Smithsonian Magazine referred to a recent study where scientists have been studying T. dohrnii to see whether humans could deal with the ageing process in a more effective way. The researchers made it clear that it won't be directly related to our human condition: '…because we are not jellyfish.' But they do believe that their study could help us: '…find better answers to the many diseases associated with ageing that overwhelm us today.'

So, although this astonishing species can't really live up to its name, it does have an amazing power that could clearly teach us a lot. Its name might not be 100% truthful, but it is not impossible that there could have been one that has been swimming around since dinosaurs ruled the planet. Do they live forever? Well, there isn't really a yes or no answer to this question. They can in theory, but they can also die quite easily. Therefore, the most simple answer would be, it is possible, but it's highly unlikely.

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Is it possible to create practically infinite energy via nuclear fusion?

Chiara Licheri, Sydenham High School

Energy prices have been a rising issue for the past decade. Prices have increased by 54% from October 2021 to April 2022. In October 2021, the price to keep a lightbulb on at 1 kWh for 10 hours would cost £2.00; in 2022 that had risen to £3.40.The possibility of practically infinite energy would solve multiple problems for families and small businesses struggling to make it through this energy crisis. Serious nuclear fusion research began in 1951, but the first filed patent for a nuclear fusion power plant was done by Sir George Paget Thomson and Moses Blackman in 1946.

What is a nuclear fusion power plant and how was the first experiment carried out? Nuclear fusion is the process where 2 light atoms{centre of an atom} combine to form 1 single heavier atom while releasing massive amounts of energy{eg. 2 hydrogen atoms merge to create 1 helium atom}. There are currently two ways scientists are pursuing the creation of fusion reactors, these being: inertial confinement fusion and magnetic confinement fusion. Inertial confinement fusion{ ICF} is a fusion energy process that initiates nuclear fusion reactions by compressing and heating targets filled with thermonuclear fuel. Magnetic confinement fusion {MCI} is an approach to generate thermonuclear fusion power that uses magnetic fields to confine fusion fuel in the form of a plasma.

The first time nuclear fusion was experimented, they used inertial confinement fusion.The experiment entailed 192 high-powered laser beams being fired at a capsule containing the elements deuterium and tritium, heating it to a temperature of more than three million degrees centigrade, which briefly simulated the conditions of a star. In the 21st century we have exchanged deuterium and tritium for hydrogen as it is the most common and lightest element in the universe.

In 1989, the growing research on nuclear fusion abruptly stopped when 2 electrochemists, Martin Fleischmann and Stanley Pons, reported that they had achieved what is known as cold fusion. Cold fusion is a hypothetical method for achieving nuclear fusion at low temperature {such as room temperature}. This apparent phenomenon raised the public's hope of an overflowing amount of cheap energy which would soon be let down. After this discovery, multiple scientists tried to replicate the experiment but to no avail. Hopes faded with the large number of : negative replications, withdrawal of many reported positive replications, discovery of flaws and sources of experimental error in the original experiment and finally the discovery that Fleischmann and Pons had not actually detected nuclear reaction byproducts. By late 1989, most researchers believed cold fusion claims were dead and cold fusion subsequently gained a reputation as being ' pathological science'. This made people distance themselves from things such as nuclear fusion. Although it may not seem like it ,Fleischmann and Pons greatly stunted and slowed down the process and development of nuclear fusion discoveries in the near future.

Why nuclear fusion? Nuclear fusion would provide long lasting, inexpensive ,sustainable, safe and eco- friendly energy while barely damaging the environment. Because nuclear fusion is made using the most common gas {hydrogen} it would be extremely hard to run out of giving us a lifelong supply. Energy would become significantly cheaper using this method as it would be less rare. Although it may seem dangerous, there is no damage done to your body by working the chemicals and it also doesn't pollute at all.

In 1920, a scientist called Francis William Aston proved that nuclear fusion would be sustainable because he discovered it was the system stars used to create energy. Because of all these reasons many researchers have been desperate to achieve the desired result of ignition. Ignition is when you release more energy than put in using lasers to create the fusion. This result happened On the 5th of December ,2022. The U.S. Department of Energy confirmed in an announcement on Twitter that fusion ignition was achieved. The researchers used a high-power laser to fire 2.05 million Joules of energy into a tiny target containing fusion fuel. This forced light atomic nuclei in the fuel together to create heavier nuclei – releasing 3.15 million Joules of energy in the process.

This incredible accomplishment was huge for the public as it gave the realistic hope that in the future we would one day be using nuclear fusion to run the world.

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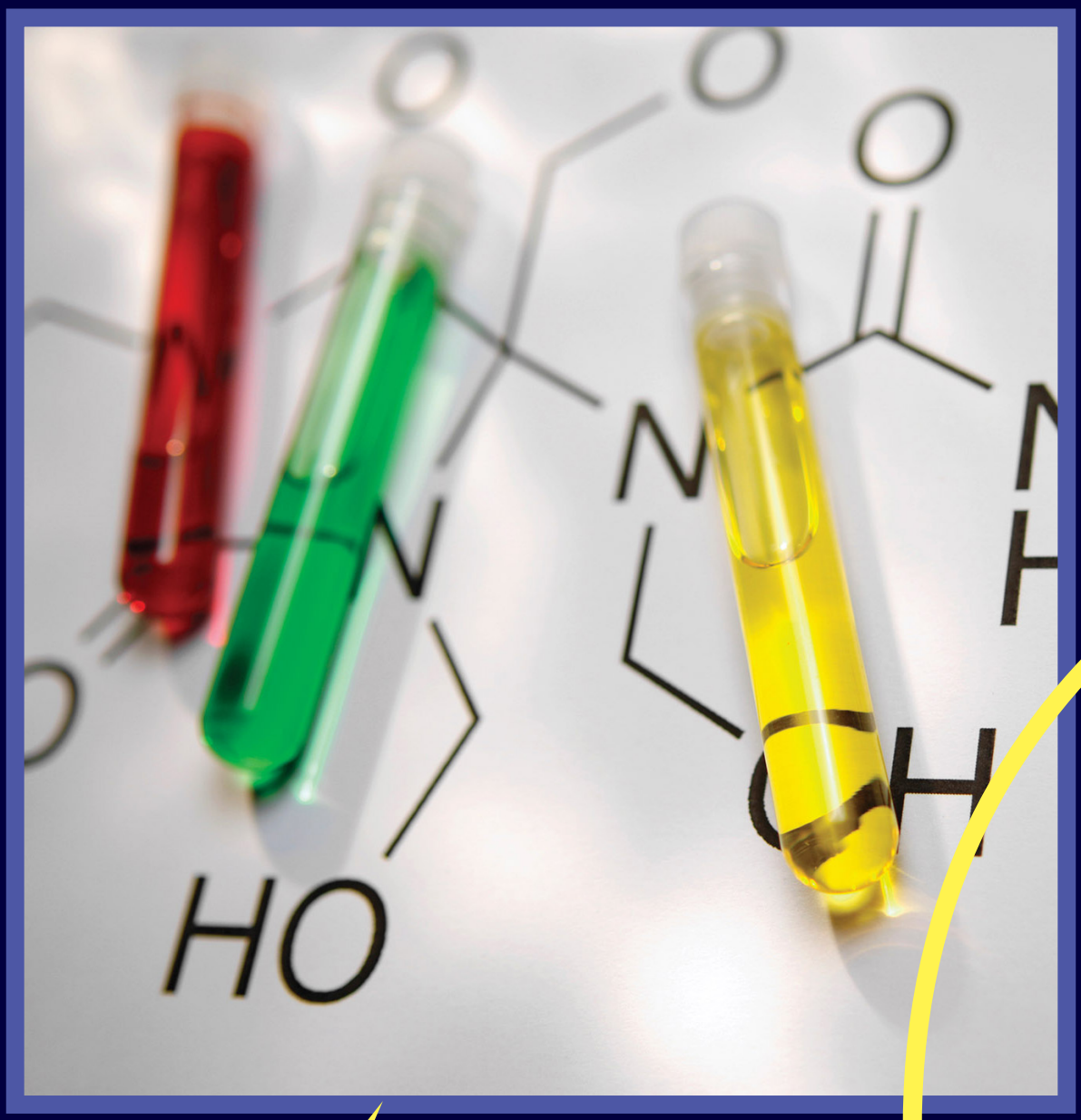
SCIENCE ESSAYS
Under 16



Is carbon mineralisation the answer to the climate crisis?

Flora Lambrette, Sydenham High School

This climate crisis is rapidly destroying our earth and if something does not change with the way we act to try and solve this problem, the consequences will be inevitable and irreversible. Many scientists are trying to find a solution to the crisis and just recently there has been a breakthrough: carbon mineralisation.

Removing carbon dioxide from the atmosphere via mineralization is not a new way of reducing carbon dioxide in the atmosphere, it has been used ever since the world was created. When it rains, the carbon dioxide in the atmosphere reacts with water in raindrops, forming carbonic acid, the carbonic acid reacts with rocks, slowly dissolving the minerals by breaking them down into their metal components. Those dissolved components then get carried by runoff and river water, and are released into the ocean. When these dissolved minerals enter the ocean, they react with carbon dioxide in the ocean to form a carbonate mineral, trapping the carbon dioxide in a rock structure.

Carbon mineralisation can now be sped up by injecting carbon dioxide into wells that go deep underground into the igneous and metamorphic rock to form solids. The main rocks used are basaltic. This is because it primarily consists of magnesium and calcium silicate, alkaline earth metals, which are necessary to form solid insoluble carbonates. Firstly one must extract carbon dioxide from the atmosphere, this is done by drawing it through a fan which has a filter material inside. When this is filled up with carbon dioxide, the collector is closed and the temperature is increased which then releases the carbon dioxide from the collector and then it's recollected to give a very concentrated gas. This gas is then mixed with water and injected 1000m underground into a basaltic rock where it is mineralised. It's mineralised by reacting certain rocks to carbon dioxide to form carbonates, the main products are calcium and magnesium carbonates. After this process happens the carbonates formed are insoluble solids which cannot release back into the atmosphere.

The main area in the world where this research is being carried out is Iceland. The operation is called Orca (Icelandic term for energy), and is the world's largest one. It has been up and running since 8 September 2021. The researchers injected 230 tonnes, which was dissolved in water, into basalt 900-1000m underground. They used tracer chemicals to show that over 95% of carbon dioxide was turned into stone within two years. These numbers are extraordinary because it was predicted to take over 30 years to mineralise but with it only taking 2 years for the carbon dioxide to mineralise it offers a real possible solution.

With every scientific discovery debates arise, discussing where it's ethical or worth the price. With carbon mineralisation the main question is: how will it keep pace with the rate of man made carbon dioxide emissions? This is a very important question because although the process can be sped up artificially 2 years is still a long time and it does not keep up with the emissions. Another challenge with this new technique is that it uses vast amounts of water, 25 tonnes of water is needed for each tonne of carbon dioxide buried. Already in this day and age many people are over consuming water meaning that less people are able to access fresh water in developing countries. However the scientists said that seawater could be used which is in plentiful supply near coastal areas, but this has not yet been tested. An important advantage of carbon mineralisation is that it's a secure way of burning carbon dioxide underground where it can't re-enable and harm the planet. However another potential challenge could be that microbes could break down the carbonates to methane, which is a very powerful greenhouse gas, but this was not shown in Iceland's research yet.

In conclusion, I believe that by artificially speeding up the process of carbon mineralisation there is hope to fight climate change.

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Not by the hair on my chinny chin chin

Keemia Satrap, South Hampstead High School

Over the last few centuries, forensic scientists have been able to identify criminals through many methods of DNA analysis, using anything from droplets of blood to fingerprints to even a single strand of hair, making every trace a critical piece of evidence. An example of this can be seen in the case of Joseph Sledge who was put behind bars for the murder of two women in 1979 through an FBI testimony stating that his hairs were 'microscopically alike' to those found at the crime scene, sentencing him to two lifetimes in prison. However, after running additional mitochondrial DNA (mtDNA) tests over 37 years later, it was found that, in fact, these hairs did not match Sledge's and he was finally released. Having been convicted at the age of 34 and released at 71, Sledge was deprived of most of his adult life as a result of flawed scientific data. Today, forensic science errors are a leading cause of wrongful convictions worldwide and the case of Joseph Sledge is just one of the many cases where innocent people have been incarcerated on the basis of "scientific evidence".

In order to combat this unfortunate issue, it is important that forensic scientists properly evaluate and utilise many different techniques available to them such as Restriction Fragment Length Polymorphism (RFLP) and Short Tandem Repeat (STR) DNA analysis as no single method is completely conclusive. RFLP is one of the earliest methods of DNA analysis in forensics, discovered in 1984 by the English scientist Alec Jeffreys. It inspects the unique patterns in VNTRs (Variable Number of Tandem Repeats - locations in DNA where a short nucleotide sequence is repeated with variations in length between individuals) in order to genetically differentiate between organisms. To be able to do this, the DNA is dissolved with an enzyme called endonuclease which catalyses breaks in phosphate bonds to cause divisions in only very specific points in the strand. Unfortunately, any DNA samples that are even slightly contaminated become unusable making it difficult to find samples appropriate for the RFLP technique.

A more common type of DNA profiling today is STR analysis as it can make use of a very small sample of DNA and amplify it through the PCR (Polymerase Chain Reaction) process which makes copies of the available biological material to produce the desired quantity for a more accurate test result. Once this has been produced, the frequency of base pair repeats in regions of non-coding DNA (areas that regulate gene expression by switching genes on or off) on the strand of nuclear DNA is investigated. This is because the sequences of 10 to 100 base pairs are repeated systematically, and this number of repetitions is highly variable among individuals allowing relatively accurate identification of criminals.

A disadvantage of STR analysis, however, is that it uses the hair root to identify the donor which, in many cases, is less likely to be found at the crime scenes due to the growth phase the hair is in. Hairs in the anagen growing phase have their roots intact and constantly yield reportable STR profiles whereas those in the telogen phase (which approximately 95% of hairs found at crime scenes are in) rarely yield informative profiles, making them futile. Therefore, the success rate of STR profiling of hairs found at a crime scene is relatively low and negative results of hair analysis are frequently reported.

After development of these DNA analysis techniques, hair samples have been recognised as a less reliable source of criminal identification. For example, the FBI acknowledged that its testimony on microscopic hair analysis was flawed in at least 90% of cases. Furthermore, the difference between microscopic and mitochondrial comparison of human hairs (as used in Sledge's case) is gargantuan as shown in an FBI study were 66 hairs out of 80 were considered unsuitable for microscopic examination and 6 were seen as inadequate for mtDNA tests - a clear example of how using only one analytic technique is insufficient evidence for such extreme penalties. Therefore, it is critical that those working in the field of law and justice are more thorough with the DNA analysis techniques used in such cases as the slightest lack of meticulousness may cost an innocent person their freedom.

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The Higgs Boson and Vacuum Decay - Could it be the end?

Penelope Pelling, Croydon High School

One day, the universe will come to an end. How it will is a question that so many have pondered over, the thought looming over their heads. There are a range of theories surrounding the end of our universe, one of which is the ominous-sounding vacuum decay. Could this be what will ultimately bring the universe to its end?

A vacuum is a space where there is no matter. They can be a true vacuum or a false vacuum. False vacuums are fairly stable and have a low energy level, but are not as stable as they can be, so are described as metastable. In contrast, a true vacuum is the most stable a vacuum could be, with the lowest energy level it could have.

Discovered in 2012 by the Large Hadron Collider (LHC) (a particle accelerator) , the Higgs boson is a particle that gives matter its mass. The way in which the Higgs boson does so is through the Higgs field - an energy field that is present throughout all the universe and gives fundamental particles (apart from the massless gluons and photons that cannot interact with the Higgs field) mass via its interactions with said particles. The Higgs boson also obtains its mass through the interactions it has with the Higgs field and the Higgs boson is the Higgs field's gauge boson, which means that the Higgs boson is a carrier of the Higgs field. The stronger a particle's interaction with the Higgs field, the greater the particle's mass is.

The Higgs field became able to give particles mass in interactions between the particles and the Higgs field when the universe was 0.1 nanoseconds old. At this point in the very early stages of the universe, an occurrence called electroweak symmetry breaking took place. The electroweak symmetry breaking caused the electroweak force to break up into the weak force and electromagnetism - two of the fundamental forces which still exist in today's universe. This happened when the Higgs field went through a change that allows most particles to have interactions with the Higgs field. As well as giving the particles which are able to interact with its mass, the Higgs field creates the charge of an electron, which is also very important to life. The way that the Higgs field exists currently - which causes it to make the mass of particles - is called a 'vacuum state' or a 'Higgs vacuum'. The universe and life as we know it would be utterly different or not be present at all if the Higgs field was even slightly different. The LHC gives us the opportunity to see the value of the Higgs field if it was able to change. Since currently the Higgs field is the metastable Higgs vacuum, it is not completely stable and could try to become a true vacuum. This is due to a concept called potential which uses maths to show how a field's value can change and the values it could change to. If the Higgs vacuum was given the opportunity to change from a false vacuum to a true vacuum it would, in an event called vacuum decay that could absolutely demolish the universe.

So, how would vacuum decay occur? Something has to happen which causes the Higgs field to get to the potential at which it could become a true vacuum. Many events could potentially cause this, including an explosion which releases an extremely vast amount of energy which is enough for the Higgs vacuum to break through the potential barrier between the false Higgs vacuum and the true vacuum state. If vacuum decay was initiated, a miniscule bubble of true vacuum ringed with a high energy wall would appear and begin to expand, engulfing anything around it and stopping forces which hold subatomic particles together and moving at the speed of light.

However, some areas of the universe could be free from the spreading of vacuum decay. This is because the universe expanding at an accelerating rate could stay out of the true vacuum's path - there is some possibility.

Vacuum decay would be so quick you wouldn't even notice it happening if it occurred. If you are reading this, vacuum decay probably hasn't happened…yet.

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The End of Everything (Astrophysically Speaking) by Katie Mack. ISBN: 978-0-141-98958-7

SCIENCE ESSAYS
Under 18

Are genetically designed babies in our future?

Chloe Wu, Croydon High School

What would the world be like if we could design humans to be however we so wished? We could eradicate life-threatening diseases and repress the effects of ageing. This may sound like a utopian dream, or, perhaps a dystopian nightmare. However, with the discovery of CRISPR, the unthinkable may have become much more plausible.

CRISPR (clustered regularly interspaced palindromic repeats) is essentially a gene editing tool. It was discovered in bacteria where it helps to fight off viruses known as bacteriophages[1]. Bacteriophages pierce the bacterium membrane and insert their DNA into the cell[2]. The bacterium then acts as a host cell. The host DNA begins to break down, allowing the phage to take over[3]. To prevent this, Cas proteins in the bacteria cut out a segment of the viral DNA and place it into the CRISPR region. If the virus attacks again, the viral DNA is then copied into single-stranded RNA, which binds to a Cas9 protein. Cas9 then searches DNA within the cell, until it finds exact complementary base pairings of the RNA molecule. If found, Cas9 cuts out the viral DNA[4]. The gap in the DNA sequence is repaired, but causes a mutation as the base sequences will no longer be the same. Therefore the gene has changed, and the virus is no longer a threat.

Cas9 was utilised when scientists found that it was programmable. If we code for specific RNA bases and insert it into a Cas9 protein, that gene will be altered. This is a medical revelation; diseases that we know to be incurable may have found their saving grace.

In 2015, scientists used this genetic engineering technology to remove HIV from Jurkat cells. It essentially worked, proving CRISPR has the ability to mutate and remove genes that code for diseases[5]. As CRISPR technology improves, the applications become endless. For example, cancerous cells multiply and hide from our immune system. Scientists could program Cas9 to modify our immune cells to become more proficient at finding cancerous cells. CRISPR may be able to cure endless amounts of diseases forever.

Although CRISPR could save thousands of lives, there are many risks that come with this. If we can use CRISPR to eradicate diseases, then hypothetically, we could also use it to change other genetics. Each of our genes code for a protein, which in turn is displayed through phenotypes (our attributes as individuals). As this efficient and cheap form of genetic engineering becomes more accepted, and our knowledge of it expands, our immune system will no longer be the only change. Vanity traits such as eye colour, intelligence and metabolism can also be altered.

If you could make your child the most talented person alive, why wouldn't you? With CRISPR, the effects of ageing could be reduced, or even stopped. We believe we die from old age due to the build up of damaged cells. However, this could end if we used CRISPR to modify these cells to stay healthier for longer. There are also organisms such as lobsters which do not have a limited lifespan. We could use their DNA, and steal it for ourselves using the gene modification tools of CRISPR[6]. This could be the transformation of humankind as we know it.

If we begin to develop technology which can alter any gene we like, by either removal or specific mutations of pre-existing genes, the gene pool of humans will be significantly reduced. These genetically modified genes will be passed onto offspring. This could, over many generations, lead to a possibility of a race of superhumans. Anyone without the desired characteristics will be rejected.

From a sociological standpoint, all of society's efforts to reduce discrimination and embrace differences will be completely undermined. On a political scale, if we give this technology to fascist or totalitarian regimes, gene modification could be used to eradicate certain types of people. Coming from a more scientific view, the natural evolution of humanity will come to a halt.

Designing babies may not be far from reality. Using CRISPR we could change human life forever. But the real question is: is it for better or for worse?

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How clinical trials are failing women

Antonia Beevor, Wimbledon High School

Drugs are a necessity in medicine; they have developed in parallel with our wider scientific knowledge. With these improvements come increased regulations to keep patients safe, for example, clinical trials.

Clinical trials allow scientists to compare the effects of different treatments to ensure that drugs are safe and effective before marketing. They are split into different phases to test different elements of a treatment. If a medicine passes these phases, it can be given a marketing licence, which makes it available on prescription. In theory, these trials should be diverse so that many different people effectively benefit from the drug, and so that researchers know how medicines affect these different people. However, clinical trials are failing to sufficiently represent one of the largest groups on the planet: women.

The representation of women in phase 1 clinical trials is very low (around 22%), and whilst it increases in phase 2 and 3 trials (around >40%) (Liu, K. A., & Mager, N. A. 2016), this isn't good enough. At this point, treatments are being adjusted to make them better, not being tested for efficacy, so drugs that could be effective on women are overlooked, and those that aren't effective are reaching production.

A paper was published assessing the participation by sex in clinical trials in the USA (2016-19) across different areas, in trials that planned to enrol both sexes. Researchers found that in 1433 trials, with over 300,000 participants, on average, 41.2% were female. To put this into perspective, 49% of people with cardiovascular disease are women, but only 41.9% of the participants were female. Heart disease remains one of the leading causes for death for women, both in the US and the UK, and yet these numbers do not reflect this. Worryingly, in diseases that affect a majority female population, the numbers also fell short. 60% of psychiatric patients are women, but "mean participation of females…was 42.0%" (Sosinksy, A. Z. et al. 2022). Furthermore, trials for cancer drugs showed only 41% of participants were female, when 51% of cancer patients are female.

This negligence doesn't begin with clinical trials. 90% of pharmacological articles describe studies done on only male animals, even with diseases that are more prevalent in women, like depression, and findings that use male mice have been proven to not generalise to female mice (Ravindran, T. S. et al. 2020). Even when it comes to studying diseases that primarily affect and kill women, they aren't even used for research.

This is important because sex differences can be substantial. There are differences present in heart mechanics, lung capacity, and the causes of disease can be different to a cellular level. Furthermore, some conditions, like autoimmune diseases, disproportionately affect women (±80% of affected). The lack of testing of drug testing on women has been found to lead to worse medical care and outcomes for female patients (Watson, S. et al. 2019).

The reasons behind this exclusion are numerous but boil down to deep-rooted sexism within medicine. Female bodies are claimed to be too complex, variable, and costly to test on, supposedly extra burdens on research variables. Some claim that biological sex doesn't matter, or, sometimes, it's just that drugs for female patients aren't worth the funding.

Period pain leads to 600 million lost work hours each year in the USA (Bavil, D. A. et al. 2016), and yet no effective treatment exists for it. Currently ibuprofen and other NSAIDs are the most frequently used for relief, but these can cause damage through prolonged use. Endometriosis, which causes intensely painful periods, takes, on average, 8 years to diagnose in the UK, even though it affects an estimated 10% of women (Rogers, P. A. et al. 2009).

Sildenafil (better known as Viagra) was used in a double blind, randomised, controlled clinical trial, and demonstrated total pain relief for periods over four hours. But researchers working on this were unable to meet their sample size due to loss of funding, and were rejected twice by the NIH when they applied for more, with comments made suggesting it was not a priority public health issue.

Women's pain is not taken seriously by primary care, and they are being underrepresented in research. Despite attempts by some bodies to force the inclusion of an "an equal balance of male and female cells, tissues, and animals" (Ravindran, T. S. et al. 2020) in research (such as by some governments' health research funding), independent drug manufacturers aren't obligated to do this. Health care must stop treating women as smaller men, or as some medical "other", but instead, as people.

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Are we going extinct?

Jenny Jiang, South Hampstead High School

Fertilization, the process of fusing sperm and egg, is a natural process that has been taking place for over 200,000 years. It is the fundamental stepping stone and driving force to evolution, civilisation, revolution, industrialisation, globalisation, and any other human-involving process that makes us human as it is today. It sparks its significance by marking the start of human life, in other words, no human life could start without this initial blessing. Sperm and egg are the two sides participating in this particularly important process, restoring a full set of chromosomes for the new life. However, a great reduction in enthusiasm of sperm, one of the two essential participants, has been observed by scientists in this century. Following the current trend, sperm could withdraw from this long-established cooperation fully by 2045.

Sperm count decline was first observed in western countries in 1992 when Carlsen et al. (1992) suggested that there was a "genuine decline in semen quality over the past 50 years". In other words, the noticeable sperm count decline started around post-WWII. This continuous rapid reduction in the west has been confirmed by the meta-analysis in 2017 (Levine et al., 2017), where an over 50% sperm count decline was observed over 40 years. Moreover, recent data from eastern countries such as China has completed the global picture of sperm count. According to Huang et al. (2017), a "significant and continuous decrease" in sperm count was also observed in China over 15 years. After gathering more data from South/Central America–Asia–Africa (SAA), Levine et al. (2022) updated their meta-analysis, concluding that this global decline is not only continuing but is continuing at an accelerated pace. So far, a clear global trend of continuous, or even accelerating decline in sperm count is well established without denial.

Dr Shanna Swan, one of the world's leading reproductive epidemiologists and co-author of the 2017 meta-analysis, extrapolated the curve of decline from the study and got an alarming result: human sperm count would reach 0 in 2045 following current projections (Swan and Colino, 2021). This issue is beyond a public health problem of male infertility, but a global crisis that could affect the future of humanity if no action is taken.

What could this mean? Well, simple: the extinction of Homo sapiens.

Sitting on the top of the food chain for so many years makes humans take everything for granted. We assume that we have absolute power against any other component in the food web since we do not have any natural predators. The idea of extinction of our own race and species might come as a side thought after deep academic exploration but was never taken seriously enough. If you say that we would be extinct in 20 years, everyone will take it as a joke, and not even a funny one. In this age of entertainment to death, in the calm before the storm, we laugh, we play, we enjoy life, but we never realise how close we are to disaster.

What has caused this reproductive crisis? There are varied factors which could affect sperm count, and more research into each factor is urgently needed. In general, Dr Swan suggested in her interview with HEAL, that environmental factors, including chemical exposure and lifestyle factors, are more likely to be the cause of this decline, as "dramatic changes of this kind in two generations are unlikely to be caused by genetics" (Health and Environment Alliance - HEAL, 2021). Furthermore, chemical exposure during pregnancy has an outsized effect on sperm quality later in life, especially during the "programming window" when reproductive traits are formed in the uterus. For example, smoking is an endocrine-disrupting activity. When a man smokes, he lowers his sperm count by 20%, but if a man was born to a woman who smokes during pregnancy, his sperm count is reduced by 50% (van Deelen, 2022). Those effects may last for generations before offspring return to normal sperm counts.

Overall, the decline in sperm count is an overlooked crisis that could potentially become a catastrophe. More research on the causes of this continuing decline is urgently needed, and actions to slow down the decline might resolve this reproductive crisis and protect the future of humanity. We are in the worst of times – we face unprecedented challenges and crises: climate change, antibiotic resistance, virus outbreak and decline in sperm count; yet we are also in the best of times - we own the sharpest tools, and the most advanced technology than ever before - there was not a time more suitable than now to resolve all the crises, which are partly or mostly caused by our ignorance. Use science, remain hopeful, and we will find our way out of the crises collectively.

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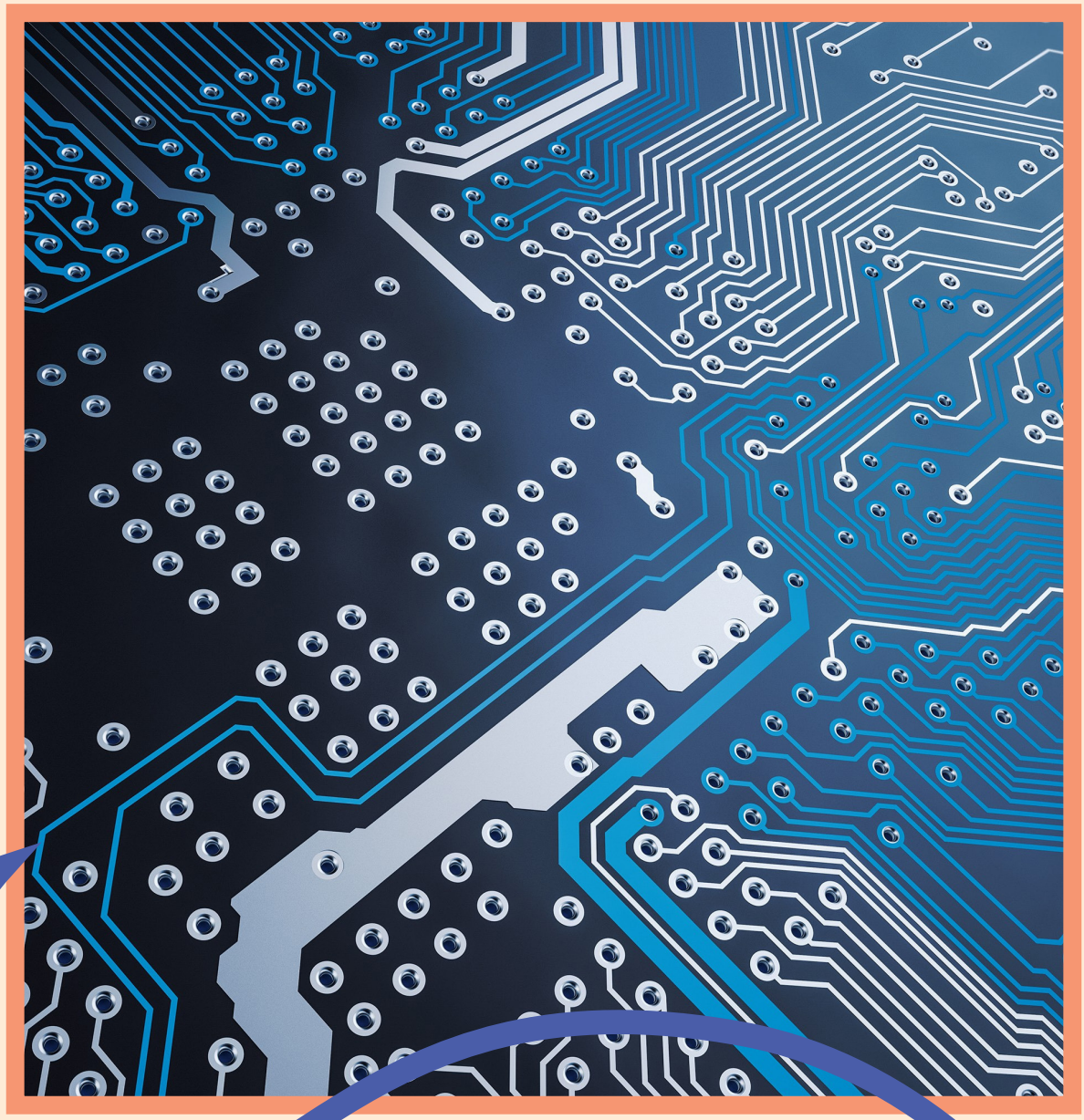

ChatGPT: The Future of AI?

Kenneth Lai, Dulwich College

As an avid and aspirational tech enthusiast, I was planning to write an essay about the Y2K problem and how it affected humanity during the "turn of the millennium", an analysis of how the iPhone revolutionised the mobile phone industry and changed what we think of as "phones" today with its radical new multi-touch interface or even an article explaining quantum computers and discussing the future of quantum computing. However, due to a rapid upsurge in the popularity of a relatively new AI chatbot, I decided to change my mind.

What is ChatGPT?

OpenAI

OpenAI, an artificial intelligence research company based in the US, has experienced multiple instances of success after being founded on 11 December 2015 by Elon Musk, Sam Altman and other eminent and reputable entrepreneurs, computer scientists and renowned figures of Silicon Valley, including Reid Hoffman, Peter Thiel, Jessica Livingston and Ilya Sutskever. Since its creation, many large technology companies, such as Microsoft and LinkedIn have worked with or invested in it. Despite this, I only discovered OpenAI recently, shortly after the introduction of DALL-E, the text-to-image generator (generates images from text prompts), which became an immediate success after it was launched and sparked many replicas. After finding out about ChatGPT, I did thorough research on its parent company and learned a lot about it. OpenAI's goal is to make AGI (Artificial General Intelligence) benefit all of humanity by creating deep (machine) learning models, as well as encouraging and motivating others to do the same. As the world moves on, artificial intelligence will continue to evolve and become more widespread, leading it to become an integral part of everyday life, and I think that OpenAI has chosen the right direction to go.

ChatGPT

ChatGPT is the conversational AI chatbot launched by OpenAI on 30 November last year, which gained popularity quickly, surpassing 1,000,000 users in only a few days. Powered by the GPT-3 language model, or specifically, GPT-3.5, the third generation of OpenAI's GPT (Generative Pre-trained Transformer) family of language models created in June 2020, ChatGPT can generate original content which simulates human dialogue and speech and yet is completely plagiarism-free. Like many NLP (Natural Language Processing) systems, GPT-3 has been trained by humans, and the purpose of the free research preview (which many people, including me, use for research and testing) is to utilise feedback from humans to rid the chatbot of misinformation, making it more helpful, truthful and safe to interact with, and therefore fine-tuning and improving the corresponding GPT-3 language model. Unlike traditional AI, GPT-3 was trained to use deep learning to produce answers, instead of having them pre-programmed. whereas the Apple virtual assistant Siri, for example, though it implements slight usage of deep learning, has most of its answers pre-programmed by developers. In other words, this conversational AI chatbot could produce an essay like this, if not even better, in a matter of seconds, which would have no plagiarism from other sources on the World Wide Web. The next-gen language model of the GPT family (GPT-4), which is planned to be released later this year, is highly anticipated and is expected to be vastly improved, with many new features, such as multimodality. This will certainly cause ChatGPT to be made even better (i.e., more accurate, human-like etc.) in the coming months.

How has ChatGPT affected the world?

After its sudden explosion of popularity, ChatGPT attracted the attention of many "tech giants", like Google, for example. Abruptly, hundreds of ChatGPT copies emerged, whether they were developed by large tech companies or just small-scale projects from business start-ups. ChatGPT was considered a "Google killer", with users preferring a clear and informational summary or explanation for their requests instead of a pile of websites stacked on top of each other. In response, Google created a new conversational AI named Bard, which was based on LaMDA (Language Model for Dialogue Applications), Google's own language model created in 2021 (which resulted in failure). Furthermore, Microsoft, a backer of OpenAI, joined the competition with Google with the new and improved Bing, which made use of ChatGPT technology, as well as Edge, Microsoft's web browser. Elon Musk, who resigned from OpenAI in 2018, said, "ChatGPT is scary good. We are not far from dangerously strong AI."

ChatGPT has also impacted the education industry in various ways. The head of Alleyn's School in Dulwich, with the fear of students using ChatGPT for homework, decided to scrap essay homework for pupils after an essay written entirely by the chatbot was given a perfect grade (A*) after being marked by a teacher. Many students and teachers have started to realise the potential of ChatGPT and have become aware of what can be done with it. To combat the use of ChatGPT in schools and other educational institutions, Edward Tian, a

22-year-old computer science student at Princeton University created a text detection tool with the ability to tell the difference between text written by humans and AI chatbots, which was almost always correct when determining different texts. Currently, this anti-plagiarism app is starting to become popular amongst schoolteachers, being a relief from the worry of students using ChatGPT for homework and other purposes (e.g., for writing competitions like this).

On the other side of the spectrum, ChatGPT has also been received with negativity. Nick Cave, an Australian singer and songwriter criticised a song written by ChatGPT in his style. Many others also expressed their feelings towards the AI with criticism. Personally, I think ChatGPT is an innovative new conversational chatbot, even though it has limited knowledge of recent world events and is prone to supplying biased content or misinformation and can still be manipulated to be harmful as an AI trained to be safe, trustworthy and have a neutral tone. As ChatGPT continues to evolve, I believe that it will lead a major change in the revolution of NLP and machine learning and inspire other people to contribute.

How will ChatGPT change the future?

So, how exactly will ChatGPT change the future of AI? ChatGPT has certainly changed the world of AI a lot and encouraged other companies or businesses to do the same. It is guaranteed that ChatGPT will be integrated into many other products and applications, and chatbots on websites and call centres will take advantage of deep-learning language models instead of having automated responses. Another way ChatGPT might change society, for better or for worse, is by replacing jobs and occupations. With its ability to perform tasks that would usually require human labour, some jobs will no longer need humans, and will instead use AI to handle tasks. The journalism industry is also likely to be affected by ChatGPT, as stories or articles can be written by it, instead of humans. Since ChatGPT can create job applications and personal statements, people won't need to put in the effort to write complex essays anymore, making it much more timesaving for them.

In conclusion, I think that ChatGPT is a great invention and one which has and will continue to affect the world and society. I think ChatGPT will simplify our lives substantially, and even make us lazier, but there's a fact that will always remain true – artificial intelligence will never replace humans.

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CRISPR Gene Editing: Genetic Savior or Ethics Challenge?

Sophia Glukhovskaya, South Hampstead High School

CRISPR/ Cas9 is a revolutionary technology making gene editing easy and affordable. Previously, this mechanism was only observed in bacteria, but scientists discovered how to use CRISPR/ Cas9 as a gene editing tool. This new tool can help us revolutionise humanity.

CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats, which bacteria use as a part of their antiviral defences. CRISPR allows bacteria to remember specific virus' (or related one's) genetic codes if they survive them. If that virus attacks again, the bacteria can make specific RNA segments that disable the virus' function and stop it from taking over the bacteria. CRISPR/ Cas9 work together to splice genes and edit them. They do this by guiding the Cas9 enzyme to the gene using a guide RNA and cutting the gene using Cas9. Then, it is possible to add, delete or copy specific genes to create different results.

Is it possible to edit certain genes in living creatures? Surprisingly, yes! A team of Chinese scientists at the Southern University of Science and Technology in Shenzhen led by He Jiankui has tried gene-editing embryos. They planned to eradicate a gene named CCR5 to try to make the babies resistant to HIV, smallpox and cholera. These embryos have become real kids named Lulu and Nana (twins) and Amy. They were born healthy. Another attempt to apply CRISPR to modify human embryos and cut out a heart disease-causing gene was implemented by Shoukhrat Mitalipov, who directs the Center for Embryonic Cell and Gene Therapy at Oregon Health and Science University. They didn't succeed, but that doesn't mean that the core technology is a failure. A further example is modifying groundcherry, where scientists used CRISPR/ Cas9 to make it grow better and produce bigger fruit.

As with recent developments, like AI, CRISPR/ Cas9 is a controversial technology, raising ethical questions like "To what extent is the intervention ethical?", "How can it save lives?", "Will it improve productivity?" These questions are not without answers, though, CRISPR/ Cas9 has massive potential to save lives. With examples like the ones above, it is almost impossible to show how it won't save at least some people's lives in the future. Groundcherry is a good example of how it can improve quality of life. With CRISPR/ Cas9, we could improve the nutritional qualities of some foods and make healthy substitutes for things like chocolate. Also, we could make soya have more nutritional value, leading us to reduce the demand for meat and livestock. As for intervention, every country and state will probably have different laws for gene editing, and it is tough to create a solid hypothesis on where to draw the line.

There is a dark side to this technology, though. When making edits with CRISPR, we might make some unwanted ones and create health problems. For example: when gene editing an embryo, we could make it have an unwanted disease or not even fix the problem that was supposed to be fixed. This could have terrible effects on humanity. If many little changes go unnoticed, it could make a huge change in someone's health. Also, even if CRISPR/ Cas9 is advertised as cheap, companies can increase the prices for lots of profit but only making it accessible to the rich, and widening the gap between rich and poor as poor people will be exploited under the new and genetically improved (and probably smarter, resilient and stronger) rich people.

Overall, gene editing and CRISPR/ Cas9 technology has a lot of potential and will probably be used more and more as time goes on. Humans will probably overcome its downsides and make it a very widespread and ubiquitous technology and will go to new heights.

New technologies like CRISPR/ Cas9 or AI pose a challenge to humanities subjects like psychology or philosophy. Getting many philosophers or psychologists to investigate these STEM-based technologies and their ethical boundaries.

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Footnotes:
(DNA is deoxyribonucleic acid, used as the 'instructions' while RNA ribonucleic acid is the 'reader of instructions')

Is Space Tourism Ready to Launch Yet?

Noor Bokhari, South Hampstead High School

Space tourism is the ability to give ordinary human beings the chance to become astronauts and experience space travel for leisure. It is a new concept that is being currently explored and has many areas to discuss. There are not many available resources in this subject area therefore, some of the information in this essay may be outdated. The following essay will highlight some, out of the many, potential areas within this universally large category and decide whether space tourism is ready to be launched globally.

The history of space tourism is recent and commenced with the 21st century although it is believed to have started with the space race. The first official space tourist is Dennis Tito in 2001. Dennis spent a week onboard the ISS after being launched by the Russian Soyuz spacecraft. There are multiple space tourism companies that have been started since then including Virgin Galactic, SpaceX and Orion Span. It has now become more commercially available to the general population since 2021 yet it is mainly for the wealthier in the community. Orion Span is a company that aims to launch the first space hotel. In May 2018, the construction commenced and in 2021 it is reported that it had been successfully launched and was meant to be admitting guests in 2022. However, it is believed that the mission has been abandoned due to the cost of the mission.

Space tourism has the potential to be a source of revenue for the space industry and have a positive impact on the economy. The space tourism industry can boost economies by creating hundreds of more jobs across the globe and encouraging further investment in this field. Additionally, it would help to make many more advancements in research and technology; this would help discover more about the environment of space and the effect of it on human beings both mentally and physically. Space tourism will inspire a new generation of engineers to work in this relatively new field which has more hands-on jobs. Furthermore, travelling to space is expensive and only accessible to few people but with space tourism becoming more popular, the cost of this may decrease to become more available to the whole of society.

On the other hand, space tourism has many negative impacts. First and foremost, when launching a rocket, the ozone layer can be damaged by the gases – such as chlorine, black carbon (soot) and nitrogen oxides – that are emitted in by rocket launches. The ozone layer is crucial in sustaining life on Earth and protects us from protecting human health; these gases pose a life-threatening challenge in space tourism. The soot released when launched would result in a more drastic global warming. When a rocket is launched, many extra fuel tanks and supplies are discarded in space when they are used, resulting in a lot of "space junk". This means that space is being polluted and these large objects may eventually hit us on Earth. Space tourism could also cause a decline in a country's economy as the sum of creating rockets to launch one into space is not simple to obtain. If one invests in starting a space tourist hotel, it would mean betting on a unstable concept as if this project fails or crashes down, then this is a huge loss of money. Space tourism can have a negative impact on human health and behaviours as the increase in radiation exposure can be deadly as well as the lack of gravity. It could also lead to many deficiencies due to the lack of fresh food and water; the lack of fresh air could lead to depression as well as the lack of greenery; the oxygen would not be fresh either. Space is a dangerous place and space tourism introduces hundreds, if not thousands, of new risks.

Overall, in order for space tourism to be successful, it would require decades more of research, experimentation and financial deficit. As mentioned before, the concept is relatively new and generally speaking, all old ideas were once thought new and unachievable. Space is perilous, life-threatening, expensive as well as damaging therefore, I believe that space tourism is not quite ready to launch just yet.

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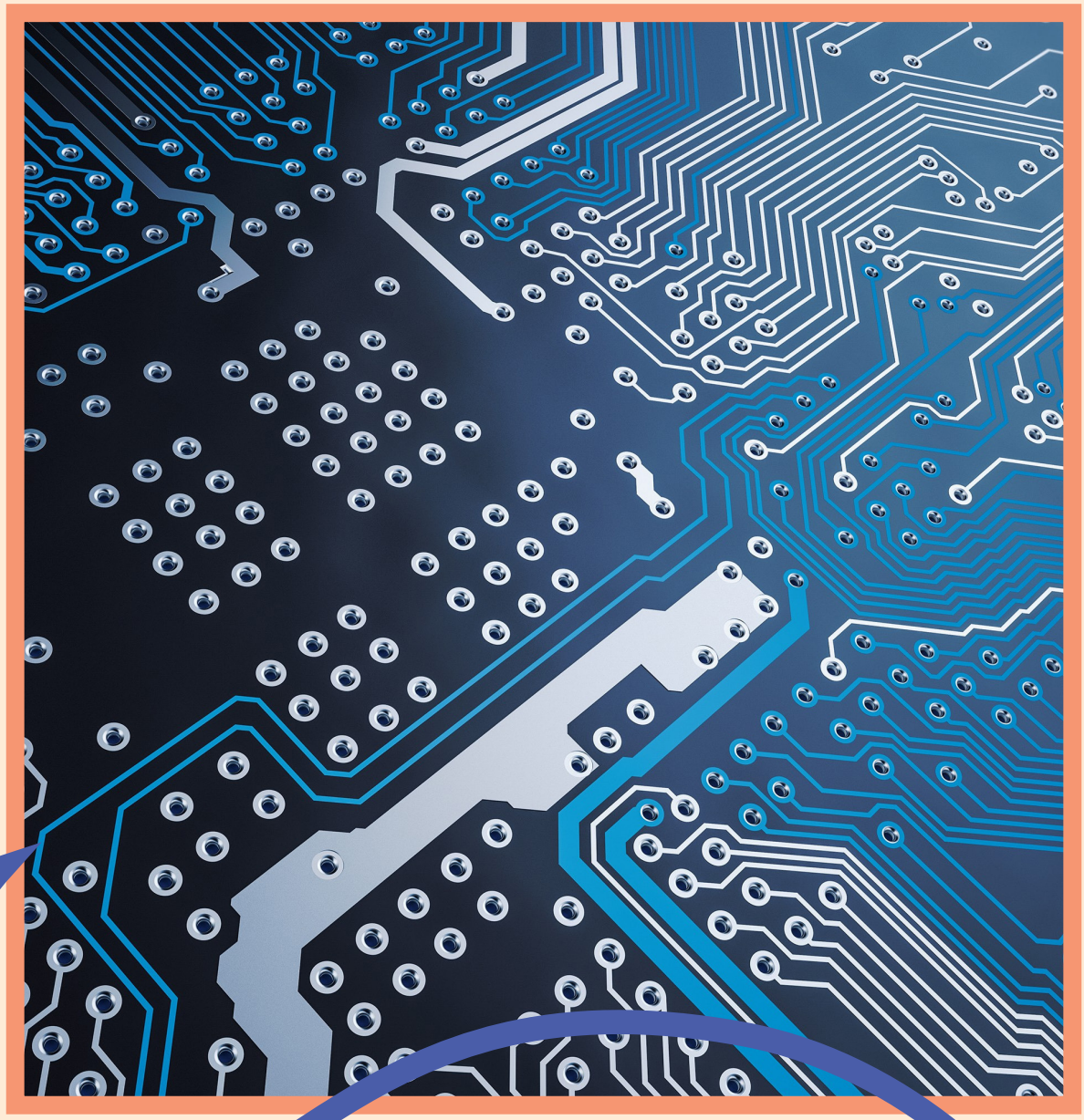

The Technology of Film

Saskia Onasanya Bell, Sydenham High School

Cinema and film have played a large role in a culture and society for decades now, and as the industry continues to develop new technologies are created that bring us even more awe inspiring and intense experiences. With the invention of special effects, films have taken on a completely new life separate from anything we could have imagined through the use of computers. We can build worlds only comparable to those which exist in our imaginations and now some of these technologies are beginning to branch outside the industry, breaking into even the medical world. This article is going to introduce you all to the wonderous world of motion capture technology.

First, I'll explain how motion capture works and what it is. Motion capture is the process of capturing and recording a person or object's movement and then using that information and applying it to a character, 2d or 3D model. When it includes the capture of expressions and small gestures, it's called performance capture. This is specifically its use in the genre of film making and the realm of video games. It works by placing sensors all over the body of an actor; these sensors will track and record all of their individual movements. This then allows their movements to be recorded and mapped on a computer screen in real time, building a virtual skeleton which can be worked over by animators and separate computer programs to build a virtual set for the movement.

I think the most well-known and widely recognised use of motion capture in Cinema would be James Camerons 'Avatar'. Avatar is one of the most successful films to hit the box office to date and there's a reason for that. It was revolutionary when it was initially released in the late 2000s, and baffled audiences with its hyper realistic CGI which was only just an emerging art form at the time. The CGI managed to appear and mimic high resolution photography, allowing the filmmakers to build a world that was uncannily realistic. All of this was achieved through the use of motion capture technologies. And, furthermore, when viewed in 3D by the audience, created an experience that can only be described as otherworldly.

However, motion capture technology is not exclusive to the world of cinema, and it's used quite frequently in the medical industry. Motion capture technology is actively being used by doctors to assist in diagnosing and treating their patients. Motion capture can be used to actively help patients with a large variety of both physical and psychological disabilities. Motion capture is an extremely non-invasive way to capture and analyse movement that requires minimal discomfort to the patients and allows doctors and physicians to make more accurate and informed judgements based on the data collected. Some examples of medical disciplines that utilise motion capture are orthopaedics and preventative medicine. Orthopaedics can use motion capture technology to visualise musculoskeletal dysfunction and create accurate models to base modified treatments off to suit patients' individual needs. It can capture a variety of issues such as joint angles, axel symmetries, acceleration and joint stress. This data is then compared to standard values to identify issues. Motion capture is currently also used in athletics and can be used to identify an injury before it happens, through analysing an athlete's technique and form. Besides these reasons it can also be used to identify movements that can contribute to chronic injuries over time, lessening the risk of developing conditions such as arthritis and tendonitis

Motion capture is also be used in the medical world to track the onset of diseases that impair movement. Tests were done in the UK on patients with Friedreich's ataxia (FA) and Duchenne Muscular Dystrophy (DMD) in separate studies and researches have stated that this technology could potentially also be used to monitor patients recovering from diseases that impair movement. Without the use of motion tracking, collecting the data of the severity and progression of these diseases can take years. It is normally measured in a clinic where patients complete sets of standardised movements. This data is necessary for the final assessment to determine the correct route of treatment. Motion capture can make this significantly faster. Professor Aldo Faisol of Imperial College London, one of the researchers in this development, states "Our new approach detects subtle movements that humans can't pick up on," he said. "It has the capability to transform clinical trials as well as improve diagnosis and monitoring for patients."

To finalise this essay, I hope I have convinced you all of the incredible wonders and applications of motion tracking and the potential of the technology of film.

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AI and Education: The dangers and possibilities

James Crawford , Streatham & Clapham High School

With the rise in capabilities of artificial intelligence that we have seen recently, AI has become a hot topic. The release of the popular AI language model ChatGPT in November 2022 brought publicly available machine learning technology to a new level, there is also currently the prospect of Google launching its own chatbot "Bard AI" as well as Microsoft's release of a new version of Bing powered by ChatGPT technology. Although advancements in AI have been long expected and speculated about, we are still somewhat underprepared for the changes that come with the advancement in this technology. This is particularly true for effects AI language models may have on education. While people often think about possible extreme consequences AI may have, there is a real need for realistic discussion about how AI can be utilised in school systems and what dangers it may hold for education in the future.

One significant concern is the risk of plagiarism. Students could easily use AI to cheat by claiming a chatbot's work as their own. This poses many issues and threatens numerous common teaching practices, like written homework, if AI language models are commonly available what's to stop students using AI-written text for their out of class/unsupervised work? Technology has been developed already to deal with this, such as OpenAI's new "AI Text Classifier", which was released earlier this year and aims to identify text written by AIs, however these programs are currently far from perfect (at the moment it only correctly identifies 26% of AI-written text) so it will be a while before we can fully rely on them. There is also a danger that certain AIs may become too advanced and learn to overcome detection even once these programs have become useable.

However, AI could have the potential to improve education by dealing with some of the limitations of human teachers. AI may be able to better tailor educational resources to individuals and personalise learning, which could be a valuable tool in schools, especially where staff are overstretched and unable to do this effectively. Machine learning technology also promises to be useful in automated exam marking, which would save teachers the laborious and time-consuming task. This does however raise concerns about the threat of computers taking teacher's jobs, if programs can be successfully developed to perform teacher's tasks will we see a decrease in demand for teaching staff? It is very unlikely that AI could replace teachers completely, the importance of human bonds is undeniably important in education and children's lives as a whole, so even if AI could be perfected for these tasks it is almost impossible it would threaten jobs in education significantly. Machine learning technology could also heighten the effects of the digital divide. Lockdown showed us how technology can provide unfair advantages in education, private schools were able to teach remotely more effectively than state-funded schools because their students were more likely to have access to a device and reliable Wi-Fi, and private schools could afford technology to aid learning. AI educational tools could have the same effect as they are expensive to use, so education-enhancing programs may only be affordable to a fortunate few. This could have serious implications for equality in education and will need to be thought through and dealt with if AI tools become more widespread to ensure that everyone can experience the benefits of this technology.

There is also the question of how far we can trust AI. Transparency is key if we are going to begin to utilise AI, we need to know how machines are being taught, and with what information, if we want to rely on them. This will prevent bias in these programs and the spread of misinformation, and will allow accurate judgement on whether it is safe to use certain language models in education. It is also vital that any information obtained by AI programs is secure if we are to use them in schools. Uses like tracking student progress and marking exams will only be feasible if we can ensure all information gained is private and used only for approved purposes. Overall, AI promises many positive uses for education, but it is crucial to be realistic about the possible issues that may come with this technology. We need to recognise, discuss, and combat the dangers involved in the use of AI technology in schools by putting the correct policies and infrastructure in place. And hopefully in time AI will be able to reach its full potential within the school sector and change education for the better.

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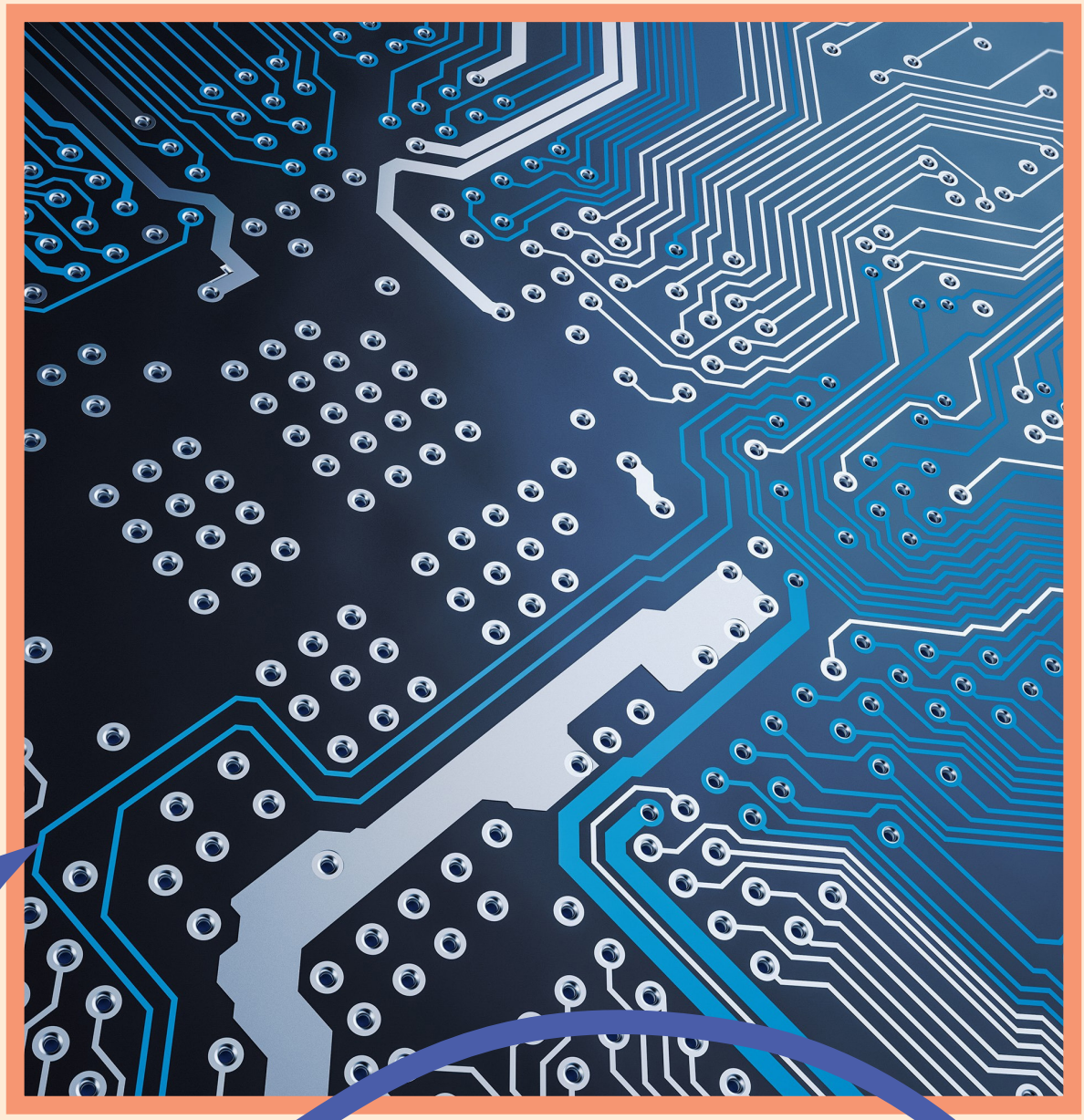

Earthquake engineering

Lucas Hector, Dulwich College

Earthquake engineering started in the 1960s in Canada, not long after one of the worst earthquakes recorded was seen in Chile which left 2 million people homeless and had a magnitude of 9.5. The Canadian national committee for earthquake engineering was formed in 1963 as an associate committee of the national research council. Since then, earthquake engineering has come along a long way and has evolved to become more efficient and reliable.

Seismic loading is one of the main concepts of earthquake engineering. This means the application of an earthquake generated agitation. This can happen at any contact surface of a structure with either the ground or any structures adjacent to it. One of the main ways in impacting how much seismic load that a structure can take is seismic vibration control is a set of technical means aimed to mitigate the seismic impacts that an earthquake has on structures. When a seismic wave starts to penetrate the base of a building, their energy flow density reduced by up to 90%, due to the reflections of the seismic waves in the earth's crust. However, the remaining energy still in the earthquake can still have devastating effects on the structure. The ways that engineers try to control these waves are:

- to dissipate wave energy in structures
- to disperse wave energy between a range of frequencies
- to absorb the resonant portions of the whole wave frequency band.

The main ways of doing this is through hysteric dampers and base isolation. A hysteric damper is made to provide better and more reliable seismic performance, which is a structure's ability to sustain its main functions during seismic activity, compared to that of a conventional structure, by increasing the dissipation of seismic energy that is put into a building.

There are many types of hysteric dampers, two of the most used are fluid viscous dampers (FVDs) and friction dampers (FDs). FVDs are usually added to enhance a damping system. They have an oval hysterical loop and the damping depends on the velocity of the wave acting on it. Friction dampers are usually available in two types: linear and rotational; and dissipate energy by heat. The damper operates on the principle of coulomb damper, which is a type of constant mechanical damping where a systems kinetic energy is absorbed due to the sliding friction. A disadvantage of this is that due to friction they can be worn out very quickly and easily. They also have a rectangular hysteric loop, meaning that if the structure is sufficiently elastic then they will return to their original shape. Base isolation is also a common way of vibration control. Base isolation prevents kinetic energy from being converted into elastic energy which could cause damage to the vehicle. They do this by isolating the structure from the ground so has no direct contact with the ground so that the structure can move somewhat independently. The degree to which the energy is transferred into the structure and dissipated throughout the building depends on the technology used. Common types of base isolation are lead rubber bearing and springs with damper base isolation.

Another main concept of earthquake engineering is that of seismic design. Seismic design is the way that the design of a structure is changed to improve seismic performance. The three most reliable and therefore most used in newer buildings are reinforced concrete structures, prestressed structures, and steel structures. Reinforced concrete is concrete where a steel bar has been incorporated in concrete.

This strengthens materials that may otherwise be brittle, it does this by supplementing the compressive strength of concrete in beams. Prestressed structures is dependent on the prestressing of its materials which is the intentional creation of permanent stress in a structure which will improve its performance. Lastly, steel structures are also a very reliable building design, as it is both a strong and partly ductile material.

Ultimately, earthquake engineering has saved countless lives. Although this is true, it still has a long way to go emphasized in the recent earthquake killing 11,500 people in turkey. Which is why engineers around the world will continue working hard to evolve the seismic performance of buildings in vulnerable areas.

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Spider-Man to Ant-Man: Insect Biology in Superhero Lore

Riva Mehta, South Hampstead High School

Superheroes have long captivated our imaginations with their enviable and awe-inspiring powers which seem to defy the laws of nature. From the web slinging Spider-Man to the shrinking power of Ant-Man, the superhero universe has gifted us with wonder and inspiration. A popular proverb states that "we fear what we do not understand". Therefore the question is: can we understand these superheroes? In this essay we will explore some of the most iconic characters inspired by the amazing adaptations which have allowed insects to survive and thrive for millions of years, as well as the real-world applications of these concepts in fields such as medicine and engineering. So put on your cape, suit up, and let's explore the biology behind these superhero skills!

Firstly, the skill of spiders to spin webs is one of their most renowned adaptations, and thus a key feature of Spider-Man, who is primarily known to shoot webs from his wrists. Spiders construct webs using specialised glands in their abdomen which release silk proteins. These proteins are then extruded and manipulated through spinnerets, (conical structured organs on a spider's underside which control the shape and width of the web). The spider silk itself, also has a high tensile strength and elasticity, which allows it to absorb vasts amounts of energy and deform without breaking. Therefore, by studying its molecular structure, scientists have been able to formulate new materials with an unexampled combination of mechanical properties, from bulletproof vests to artificial tendons.

Another vital adaptation of spiders is their ability to climb walls, which has inspired Spider-Man's acrobatic talents. Spiders are able to stick to almost any surface using tiny specialised hairs on their legs (setae), through a combination of friction and adhesive forces (resulting from a combination of capillary action, Van der Waals forces and electrostatic attraction). Spiders control this adhesion through altering the angle and pressure of their legs, permitting them to easily move in any direction. A similar principle is also at work in gecko lizards. The consequential study of these aptitudes has also led to the development of new materials that can be used, from medical adhesives to climbing robots which can mimic the insects' gripping ability.

Additionally, Spider-Man's 'spider sense' or Daredevil's 'radar sense' to sense danger, is another example of how insects have inspired superhero lore. Although not based on a proven natural ability, they clearly link to the biological concept of intuition and could also link to the heightened awareness of spiders' surroundings as they are able to sense external vibrations through specialised body hairs (trichobothria), quite like a high-tech surveillance system. By studying how spiders use these hairs to detect prey and predators, researchers have developed new wearable sensors for detecting environmental changes, such as in seismic activity and air pressure, helping save lives.

But it's not just spiders that have inspired superhero characters. Ants, which are famous for their teamwork and strategical skills, are reflected in Ant-Man's power to communicate with and control ants. Moreover, his ability to shrink to the size of an ant whilst maintaining his human strength is influenced by the ability of ants to carry objects up to 50x their own weight and shrink to tiny sizes by manipulating their size and shape (allometric scaling). Thus, by studying the genes and proteins involved in this process, researchers have been able to manufacture new methods for controlling the size and shape of cells, which is extremely important for regenerative medicine and tissue engineering, especially in the future. Insects have also inspired heroes in less direct ways. For instance 'green hornet' was named after a species with potent venom. Similarly, 'the wasp' borrows her name from the insect she resembles as she has stingers and the ability to fly.

In conclusion, the world of superheroes contains a multitude of characters that draw on and highlight the immense diversity of insect adaptations. The exploration of these, give us a deeper appreciation for the natural world and the impact it has on our lives. From the development of new materials to technologies, the applications of insect biology are extensive and irreplaceable. And as we continue to explore the natural world, we may find ourselves creating evermore superheroes.

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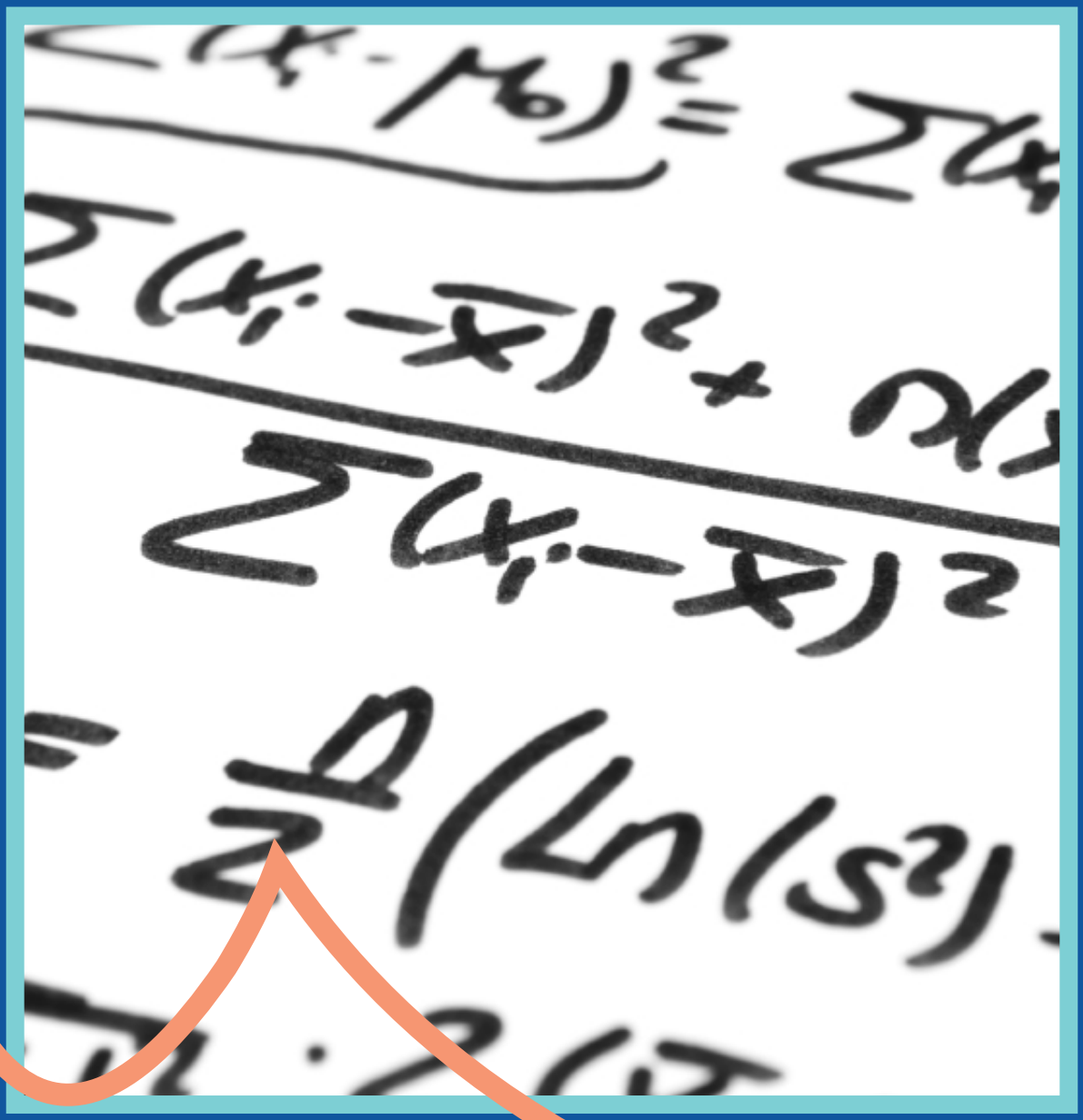

The value of statistics in modern-day decision making

Imogen Andrews, Wimbledon High School

From political decisions, to what we eat for lunch, facts and statistics effect our everyday decisions. We put weight on them, and sometimes make lifechanging decisions purely because of numbers. Sometimes, in hindsight, these decisions are right, and sometimes they are wrong, like all decisions. However, our decision making depends on a careful ratio of emotion and empathy balanced with facts and statistics. But which of these two help us make the best decisions? Other factors that affect our decision making also need to be addressed. Studies show that heritage, environment, culture, and age all affect decision making hugely (Iyengar, 2010). However, when we have to make important decisions, people often end up wondering what to trust more: their head, or their heart.

Some would argue that statistics should hold more sway over our decisions. For example, many of the decisions the government made during Covid 19, such as where they would set up temporary hospitals, were made based on statistics, about where people live, the amount of people catching covid, and how full the local hospitals were. Without using statistics like this, it is difficult to make decisions, as the location and numbers are very important. Another example could be unplugging life support when a person is in a coma, a difficult decision that sadly many families are faced with. In this scenario, without statistics about likelihood of survival, or when and if someone will wake up, this decision becomes almost impossible, as nobody wants to lose a loved one. However, by giving someone facts, it would help them make this decision, as if someone knew there was, for example, a 90% chance someone would wake up, and eventually be able to survive without life support, then their family would decide to keep life support on, however if the chance of them ever waking up or surviving without a machine was far lower, then someone may make the difficult decision to turn off life support.

However, on the other side, removing emotion from decision making would be catastrophic, and would lead to unempathetic and often selfish decisions. As a species, we pride ourselves not only on our ability to think logically, but also to sympathise, and feel a wide spectrum of emotions. Looking at the life support example from a doctor's perspective, if there was a 10% chance someone would wake up, a doctor may think that even though there is a considerably high chance of survival, the hospital bed could be better used on someone else, and the vital equipment being used to keep this person alive could be used to keep someone else alive. However, an emotive, empathetic response to this wouldn't have a set answer, which is why we sometimes undervalue the importance of emotion in decision making, as we don't think it will help us as it won't give us a black and white answer. However, the world isn't black and white, and there are so many different opinions and sides, and by closing our minds off and refusing to bring emotion and feeling into our decisions, we are patronising the complexity of the world.

Let's look at another example. Say someone with a neurological difference is debating taking drugs to change their behaviour or not. In this, statistics are used to tell someone the effectiveness of a particular drug, and how it has affected others, and along with information on this person's health, the effect different dosage may have on them can also be predicted and improved using statistics. However, the idea of medication worries some people, and in this situation, this decision should be made with both statistics, and emotions. If you feel like you are in a downward spiral and feel that this medication could help, then your emotions are probably going to be more important in this decision, and if you are scared medication will supress your brain, or perhaps numb you, then these feeling and worries are valid too.

Associate Professor Petriglieri (2014) said "We want cool heads and warm hearts—as long as they remain apart." However, in conclusion I belive it is crucial in decision making to combine our feelings and statistics to make overall better decisions, although circumstance does come into it too. By combining stats and feelings, we are addressing that there isn't always a right answer, while making sure we are equipped with the necessary facts to make an informed decision. Of course, bias is also a factor in many scenarios, and while people would argue that this proves we shouldn't let our heart lead in decision making, I believe this argument is invalid, as sometimes we need to make things personal in decision making.

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How To Find a Partner: The 37% Rule

Arwa Kinana, Croydon High School

With Valentine's Day having passed a few days ago, many people feel many different ways about the topic of relationships. But imagine you are (painfully) single and wishing to be in a relationship; for some of us, this won't take much imagination at all. You look to everything for help, from the gossip column in your local newspaper (not very helpful) to your friend describing in painstaking detail her ideal type (not very helpful either). But how can maths help you find a partner?

$$P(r) = \frac{r-1}{n} \sum_{i=r}^{n} \frac{1}{i-1}$$

This equation could be the solution to your dating troubles, using a mix of logic, probability and decision making. It can also be applied to other situations, and for this reason goes by several names, such as the Marriage problem, the Sultan's Dowry problem and the Googol Game.

This is often seen as the Secretary Problem. Let's suppose that you are a boss looking to hire a secretary; you aren't aware of the skill of a potential employee until you interview them, and at that point (after the interview) you can choose to accept them or reject them. The only catch with this is that once you have rejected someone, you cannot go back and hire them; once you have accepted someone, the whole interview process stops and they are given the job.

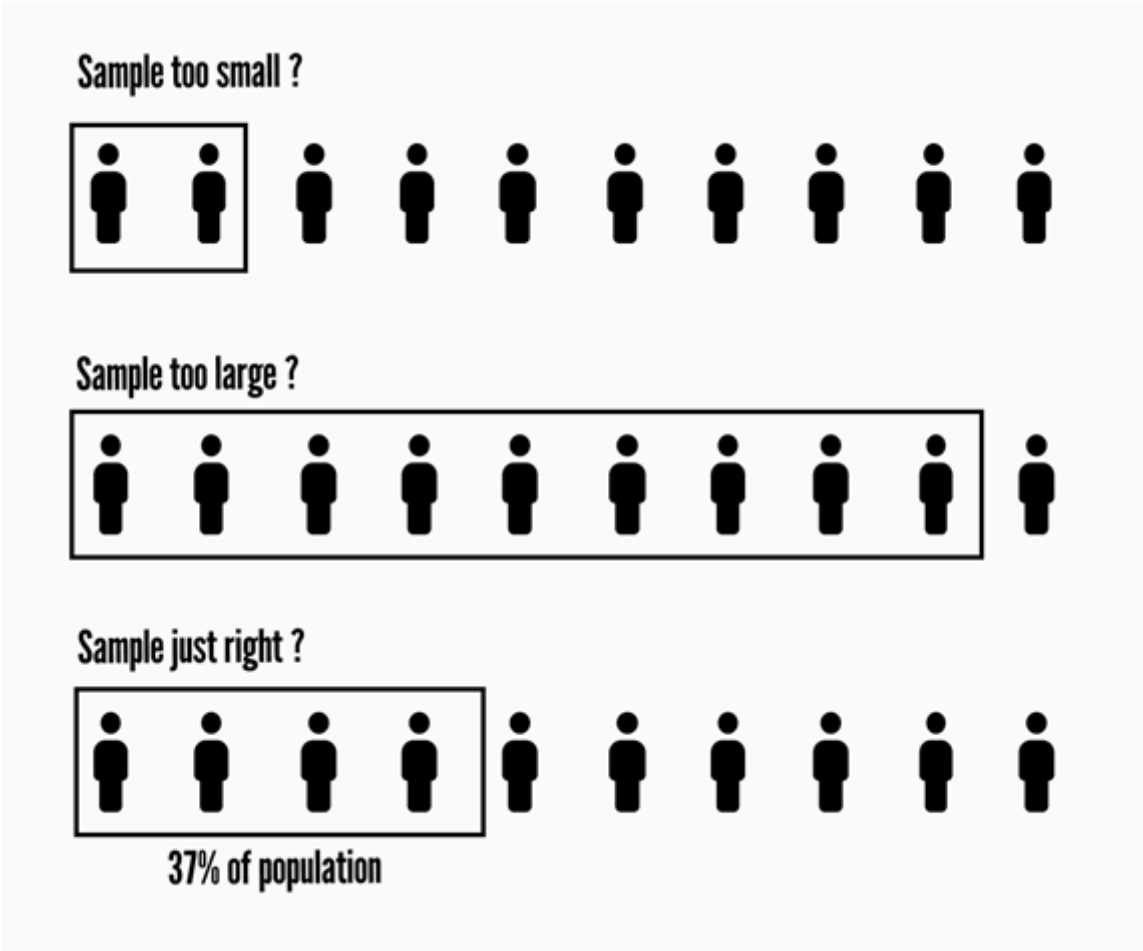
How can we maximise our chances of finding the right person for the job - and why should you care anyways? Just remember the value 37%.

As a boss, you don't want to pick too soon and risk losing the chance to find someone with better skills who is better suited to the job of your secretary. A better strategy is to meet a few candidates and use them to help your understanding of the candidates that are to come, and to then select the next best person whose skills exceed that of the highest you saw in the sample set. You don't want to leave it for too long and risk losing your best candidates to your sample set. So when do you stop interviewing and start choosing?

This is where the 37% rule comes in. The actual percent is 1/e, where e represents a constant known as Euler's number. It is actually 36.79%, but you need to round up to 37% because you can't date a fraction of a person. If you have n applicants, and you know the value of n is, let's say, 100, the 37% rule (the optimal stopping theory) says you should interview the first 37% of people and reject all 37, no matter how skilled they are. These 37 will give you a better understanding of the skills needed and the quality of applicants. From the 38th interview onwards, you must pick the first candidate who exceeds the highest level seen in your sample set of 37 people.

As you guessed, this can be applied in the dating world to find your ideal partner. The main drawback of using the 37% rule in the dating world is that we don't know how many people we may meet over our lifetime; in this case, we think of our sample using time instead. For example, if you start dating at 18 and want to get married by 38, that gives you 20 years of time to find an ideal person. In those 20 years, you should spend around 7 years and 5 months (2702.85 days, to be precise) dating but not settling; with every new person you meet, you will develop your knowledge on what your real expectations are and you can start looking for the things you know you care about the most.

Thinking about applying this to the real world, love is much more than just about maths and probability. It is hard to put a number on relationships; this rule doesn't take into account feelings, gut instincts, or instant chemistry. In any case, love is more often a matter of the heart than a matter of the head; it is based on emotions and cannot be solved by logic alone. For those of you who are single and looking for a partner, I wish you all the best in your search for love.



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What impact has data had on English football?

Honor Jackson, Croydon High School

Football is described as 'the Beautiful Game' and has been played competitively since 1863.

Since then it has thrilled and entertained audiences worldwide and provided moments of drama such as Maradona's 'Hand of God' goal and Zinedine Zidane's headbutt that ended his playing career.

The game once referenced by Shakespeare is now the world's most popular sport. But the story of how data has transformed the game is even more enthralling.

History of data in football

The involvement of data in football started in 1996 when a company called Opta Counseling (now STATS Performance) started to collect match data from Premier League games to give to club managers to show them how data could be used to help them make decisions.

Opta hired people to watch and analyse the games from the previous week and created a basic list of statistics like goals, assists and clean sheets. They began to sell their data to pundits and journalists who introduced a whole new language of football analysis as a result.

The Pioneers

Bolton Wanderers is a club that is currently 4th in League One, but in the 1990s, it was a Premier League side who were managed by Sam Allardyce.

Allardyce was inspired by his experience working in the American Soccer League to start using data to improve and modify how his team would play. He hired a team of data analysts to scrutinise other teams' performances as well as Bolton's to try and find ways to give them an edge.

The data team introduced the concept of POM - Position of Maximum Opportunity — which indicated when a goal was most likely to be scored. This led to Bolton focussing on long-throws, corners and free-kicks.They analysed where best to position players at set-pieces in order to increase the chances of the ball falling to them.

This kind of thinking and use of data had never been used in European football before.

What is XG?

The use of statistics to analyse matches has improved over time and we are now familiar with more advanced match statistics such as 'XG', a measure of the probability of a shot resulting in a goal.

Statistics is not only creating a more in depth analysis for journalists and commentators, it's also an exciting new way for fans to talk about football .

It is also creating a bridge between coaches and fans as the reasons why they have made certain choices is now backed by data, not just judgement.

Data-driven Clubs

The new world of football data doesn't just influence the managers and coaches, it affects the ultimate owners of football clubs as well.

Good examples in England are the clubs Brentford and Brighton Hove Albion.

Brighton is a club built on data. Their Chairman is Tony Bloom, a professional poker player and the founder of the UK's largest sports betting syndicate, Starlizard.

Starlizard uses intensive quantitative analysis to predict score lines and place hundred million pound bets.

Like Starlizard, data informs every decision made at Brighton, from whether to buy or sell players, to how much a player is worth and who should play where on match day.

Bloom has changed the narrative and proved that you don't need to be an ex-footballer to understand how football works. You can use data instead.

Players, Health and Data

Data hasn't just changed tactics in football, it has also changed the biological aspect as well.

Players are now fitted with wearable technology that tracks their breathing rate, heart rate, their speed and acceleration as well as the distances they cover in games.

Manchester City recently announced a partnership with Israeli technology company Playmaker to launch Cityplay, a device that transforms any football boot into a data tracker that monitors and analyses athletic performance through a player's foot movements.

Its data allows managers and coaches to identify not only how players would perform in game play situations but also alerts them if a player is at risk of injury.

Conclusion

The story of data's impact on English football, on and off the pitch, has barely begun. In the future, it will elevate the beautiful game to new heights.

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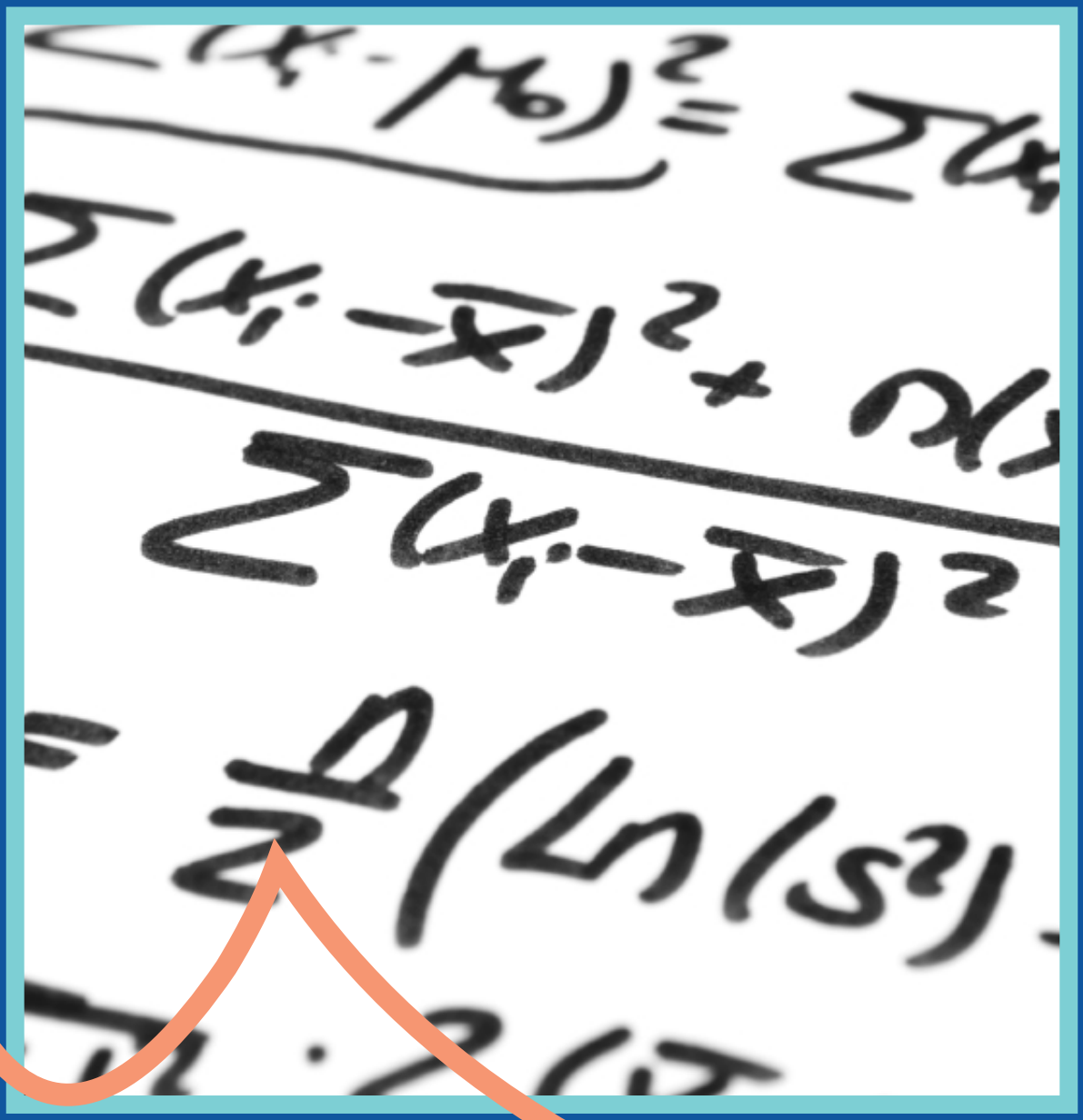
MATHS ESSAYS
Under 18

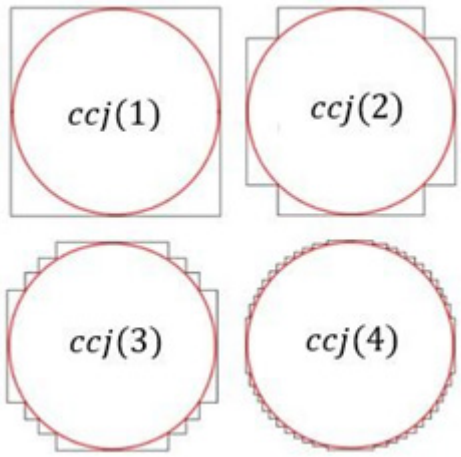


Breaking Mathematics and fixing it … with geometry, infinity and taxicabs

Theo Ladure, Dulwich College

Pi. Perhaps the most famous number in Mathematics. Defined as the ratio of a circle's circumference to its diameter, it can also be found outside the circle. In fact, it crops up everywhere from simple harmonic motion to Mandelbrot sets to mathematicians' tattoos. The 14th of March (3/14 in US date format) is even dedicated to pi! Having first been calculated as 3 by the ancient Babylonians 4000 years ago, it has now been calculated to 100 trillion decimal places. However, from the depths of the internet comes a proof that could undermine this number's calculated value as well as the very foundations on which Mathematics is built upon…

Say we inscribe a circle within a unit square. The unit square will have a perimeter of length 4, whilst the circle will have a circumference of pi. So far, so good. Now, fold in the corners as shown in the diagram. The length of the shape outside the circle is still 4 as the total horizontal and vertical distances of the shape remain unchanged. We will repeat this process of folding every corner, labelling this crazy-circum-jaggedy shape (as it is known in technical jargon) as $ccj(n)$ for the nth curve. But, as $n \to \infty$, this shape eventually converges to the circle with a perimeter of 4. So, does that mean $\pi = 4$?

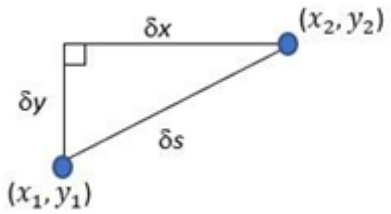


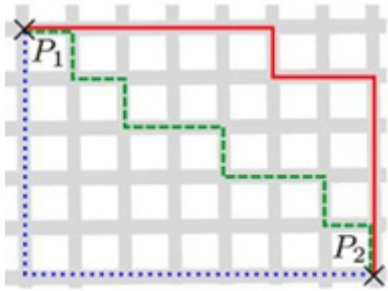
Here are most people's initial reactions in order:

1. Disregarding it as a silly joke.
2. Wait a minute…
3. Just no.

Though this proof is invalid (sorry for the spoiler), it challenges the concept of a limit – the essence of calculus – which I will be discussing in this essay.

Viewing this shape as a fractal, here is a zoomed-up image of a corner found on the circle's top-left quadrant. The limiting sum of $\cdot s$ gives the circle's perimeter whereas the limiting sum of $\cdot x + \cdot y$ is the jagged curve's perimeter.





Taxicab metric^

Perhaps the most intuitive approach uses a taxicab metric 1 in which Euclidean geometry i d_t placed with a grid of horizontal and vertical lines. Like taxi journeys in Manhattan, the taxicab distance between two cartesian coordinates (x_1,y_1) and (x_2,y_2) in $\mathbb{R}^2$ is $|x_2 - x_1| + |y_2 - y_1| = \cdot x + \cdot y$. Thus, the infinitesimal horizontal and vertical components will always sum to 4. Furthermore, as the shortest distance between two points is a straight line, $\cdot x + \cdot y > \cdot s$. This elegant interpretation asserts that the perimeter of the resulting figure is strictly greater than the circle's perimeter, hiding however the subtleties of limits which we want to explore.

Considering the epsilon-delta definition of a limit, let us evaluate the statement that as $n \to \infty$, $ccj(n)$ converges to the circle. Notice that for all $\varepsilon > 0$, there is an n such that for all $m > n$, $ccj(\mathrm{m})$ lies within the annulus bounded by the circle of diameter 1 and a circle of diameter $1 + \varepsilon$. However, this formal definition of a limit is only valid when the error tends to zero in parallel (pun intended, sorry) to $ccj(n)$. Therefore, whilst the area of $ccj(n)$ converges to the circle's (as the error in area reduces continuously to zero), its perimeter doesn't as it always maintains its error previously discussed using taxicab geometry.

The infinitesimal segment ds of this circle is given by:

$$ds = \sqrt{dx^2 + dy^2} = \sqrt{\left(1 + \frac{dy^2}{dx^2}\right)(dx^2)} = \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx$$

This gives us the arc length L from a point A to a point B on a planar curve defined by the equation $y = f(x)$ in $\mathbb{R}^2$ where f is continuously differentiable:

$$L = \int_A^B \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx$$

Therefore, to validly approximate a path's perimeter using another path, they must have the same gradient along their entirety. This is not the case here as $ccj(n)$ is not continuously differentiable (its gradient oscillates between 0 and ∞) whereas the circle is.

In addition, discontinuous functions are not necessarily commutative:

$$\lim_{n\to\infty} len(ccj(n)) \neq len(\lim_{n\to\infty} ccj(n))$$

$$4 \neq \pi$$

In conclusion, before dismissing this internet joke as useless, it has, recalling the taxicab interpretation, given us an upper bound of 4 for the value of pi. More importantly (as that was known before chickens and eggs were around), this mathematical fallacy illuminates the power of challenging the unchallenged which often leads to deeper insights, in this case being the subtleties of limits.

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Exploring the Boundless: The Eternal Fascination with Infinity

Mili Thakrar, Northwood College for Girls

Infinity is a concept that has captured the minds of mathematicians, artists, and philosophers for centuries. In mathematics, infinity represents an unbounded quantity that is larger than any finite number. However, the concept extends beyond mathematics, inspiring artists, writers, and musicians through its symbolism of the eternal, the unknown, and endless possibilities. Moreover, the nature of infinity has been subject of philosophical inquiry throughout history, causing debate among mathematicians and philosophers alike.

The number first made its appearance in ancient Greek mathematics, describing the magnitude of limitless quantities, such as the size of the universe. It wasn't until the 19th-century that infinity was rigorously defined and studied in mathematics. Georg Cantor, a German mathematician, is credited with providing the first definition of infinity and studying the properties of infinite sets.

Infinity plays a crucial role in various branches of mathematics, notably calculus, set theory, and topology. In calculus, infinity is utilised to characterise the behaviour of functions at their limits, like the infinite slope of a vertical line. In set theory, it defines the size of infinite sets, such as the set of all real numbers. In topology, infinity explains the properties of spaces that are infinitely large, such as the surface of a sphere.

Many prominent depictions of infinity can be found in religious art during the Middle-Ages, where it was often used to symbolise the limitless and eternal nature of God. This concept was incorporated into illuminated manuscripts and stained-glass windows featuring circular designs, such as mandalas and halo-like circles, to represent the infinite nature of the divine. This concept was also evident in Gothic cathedral architecture, where intricate carvings and sculptures, such as spirals and interlocking circles, served as visual representations of infinity and the never-ending nature of God's presence.

The use of the infinity symbol was further popularised in the 17th-century by mathematician John Wallis who used the figure-eight to describe limitless magnitude. This symbol remains widely accepted in mathematical circles and has been adopted by artists, as seen in the famous Mobius strip. This is a one-sided, non-orientable surface with infinite length, and is a tangible example of infinity that continues to fascinate mathematicians and artists alike.

In literature, infinity has been used as a metaphor for abstract ideas, such as love, life, and the universe. In Dante's Inferno, the narrator travels through Hell, Purgatory, and Heaven, symbolising the journey towards a limitless and eternal-state. Infinity in literature often reflects a sense of timelessness, boundlessness, and the never-ending search for meaning in life.

Modern artists are now leveraging digital technology to create pieces that explore the infinite. In music, infinity represents the idea of timelessness, with composers employing repetitive melodies and rhythms to evoke a sense of endlessness. In digital art, the use of algorithms and simulations has allowed artists to create works that explore the concept of the infinite and push the boundaries of what is possible with technology.

Infinity has also been a subject of philosophical inquiry for many centuries, with philosophers grappling with its nature and implications. Some philosophers argue that infinity is an actual property of the universe, while others see it as a human construct used to describe the limits of human understanding. The ancient philosopher Zeno of Elea famously argued that the concept of infinity led to logical contradictions, such as the paradox of the Achilles and the Tortoise. However, philosopher Georg Hegel later argued that infinity was an essential aspect of the universe, representing the potential for endless growth and development. Infinity poses profound philosophical questions about the nature of existence and the boundaries of knowledge, continuously capturing the imaginations of people from all walks of life.

The concept of infinity has left an indelible mark on the development of mathematics, art, and philosophy. Its boundless potential continues to be a source of inspiration for artists, writers, and musicians through the ages, from its origins in ancient Greek mathematics to its representation in modern art and culture. The mathematical definition of infinity has been used to explore the limits of human understanding and to express ideas about the unknown, infinite, and eternal, making it a concept that will always captivate and inspire those who seek its meaning.

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Fibonacci and the stock market: a match made in ratio?

Hrishita Chandel, Wimbledon High School

The Fibonacci sequence of numbers is a series of numbers in which each number is the sum of the two preceding numbers starting with zero and one this sequence appears in many natural phenomena such as the spirals of a Nautilus shell as well as the beautiful intricacies of the human face. These are based on the ratio between two consecutive Fibonacci numbers which is known as the "Golden Ratio" or "Divine Proportion". Its use is found several works of art from Renaissance artists.

Apart from dominating the world of arts, the Fibonacci analysis is also used in financial markets to analyse stock prices and make future movement predictions. The basic idea behind Fibonacci analysis is to identify levels of support and resistance in a stock price using various Fibonacci ratios such as 0.236, 0.382, 0.618 etc. Support levels are prices at which demand for a stock is believed to be strong enough to prevent its price from falling further. Resistance levels are prices at which selling pressure is believed to be strong enough to prevent the price from rising further. If a stock approaches its support level under showing positive momentum it is probably a good time to buy it, but if it's approaching a resistance level and is showing a negative momentum it is a good time to sell the stock. The sequence is often used by traders and technical analysts to forecast market-driven price movements and make well informed decisions about buying and selling stocks.

These numbers are said to have a strong psychological importance in herd behaviour. Statistics show that traders are more likely to take profits or cover losses at a certain price point, and these prices point are marked by the golden ratio. The increasing use of the Fibonacci retracing forms a sort of self-fulfilling prophecy: the larger number of traders that rely on Fibonacci based trading strategies, the more effective it tends to be. Traders use the Fibonacci retracement levels to identify strategic places to trade, stop losses or target prices to get a favourable price.

Critics of Fibonacci analysis argue that the importance of the sequence in the stock market is highly exaggerated and that relying on it too heavily can lead to misguided investment decisions. This is believed since it assumes that stock prices follow fixed patterns. Any stock market price is dynamic because it can be influenced by other things that are hard to predict (e.g., Russian invasion of Ukraine) and the use of Fibonacci levels can be subjective and open to interpretation which leads to inconsistent results.

Another issue with the Fibonacci analysis is that it is often used in conjunction with other technical analysis and while these tools can provide valuable information on their own, combining them with Fibonacci analysis can lead to over reliance on technical analysis and a disregard for other important factors, such as fundamental analysis' that look at financial information and economic indicators.

However, proponents of Fibonacci analysis argue that its use can lead to improved investment decisions sometimes as it provides a mathematical approach to stock market analysis. Moreover, studies have shown that the Fibonacci sequence on its ratios can be useful in identifying important price levels in financial markets.

In conclusion, while the use of Fibonacci analysis in the stock market is a controversial topic it is important to recognise that the Fibonacci sequence and its ratios can provide valuable insights into the market trends. However, it should be it should not be relied upon solely and should be used together with other forms of analysis to make sound financial decisions. Additionally, it is important to consider the limitations of this tool when making investment decisions. It is worth mentioning the beauty of mathematics and its presence in our daily lives. From the simplest of patterns to the most complex of systems, Math is a fundamental aspect of the world around us. The Fibonacci sequence is just one example of this with its present not only in the stock market but also many other areas such as art nature and architecture, it serves as a beautiful example of the powerful role it can play in shaping our understanding of the world.

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WELL DONE!

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