// Issue 02 // Spring 2013

the GIST

Glasgow Insight into Science and Technology

CSI: The Hague

Fighting crime with science!

Homeopathy // Emotional Recognition // The Glasgow Effect // Medical Reporting

TEAM GIST

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EDITORIAL

We made it! Thanks for picking up The GIST's sophomore issue, once again bringing you the finest science writing this side of Falkirk.

WHAT NOW?

Due to the work of science communicators, starting with Carl Sagan in the 1970's, through the BBC's Horizon documentaries, the Naked Scientists, Brian Cox, Alice Roberts and Richard Dawkins to name a few, scientific research (in the UK at least) has the public's full attention. There are now no less than 10 student science magazines in the UK, with React (Newcastle), Spark (York) and Synergy (Lancaster) all starting in the last year. Science blogs are too numerous to count. My question is this: Now that we have the public's attention, what do we do with it?

Journalism's highest moral function is to hold to account the industries and sectors it reports on. In this respect, a large amount of science journalism has been 'soft' journalism, and with good reason, as simply taking academic papers and giving the non-expert reader the gist (sorry) of the work is important and difficult to do well. You'll find some excellent examples of how to do it well in this issue. However, we may now be in a position to show the public that science, like any other large industry, has its problems. We've started with the quality of medical science reporting in this issue, but there are many other areas that require scrutiny. The recent backlash against paying for publication is a good example and has thrown up older questions about the quality of the peer-review system itself. Far from weakening the standing of research in the eyes of the public, a little bit of negative press might serve to pull down the final vestiges of the ivory tower previously inhabited by scientific research.

// **Alan Boyd is a 3rd year PhD student at the University of Strathclyde.**

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COVER ART by Nijole Ukelyte

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Beverley Caie

HOMEOPATHY

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Scott McKellar and Craig McInnes add their tuppence-worth to an age-old cliché.

If you're reading this there is a reasonably good chance that, having an interest in science, you think homeopathy is nonsensical quackery peddled (mostly) by opportunists and charlatans. And you're right, it is. If the object of an opinion-piece is to win the reader to the writer's point of view, then we have already succeeded. Hurrah.

Unfortunately, writing critically about homeopathy has become something of a cliché because the very nature of this "alternative medicine" is fundamentally laughable. So why are we bothering? Well firstly, we recently attended a Glasgow Skeptics lecture by Kevin Smith, a senior lecturer at Abertay University and a renowned opponent of pseudo-medicine, in which he galvanised opinion within the room that homeopathy is at best amusing hokum and at worst dangerous, deliberate misinformation. This seemed like a good starting point for us to write a self-righteously angry GIST article with all the raw power of sugar pills and crystal healing. Secondly, it seems that homeopathy is still a thriving business in the UK[1]. The NHS continues to fund homeopathic remedies, including four homeopathic hospitals, one of which is in Glasgow. Public figures such as The Prince of Wales, Nicola Sturgeon MSP and Jeremy Hunt MP have all given homeopathic care their approval[2]. These people really should know better.

Surprisingly, not many people know what homeopathy really is (not enough people anyway). Sometimes billed as an alternative medicine, we would suggest that it is an alternative in the same way that a crash mat is an alternative to a parachute. You may conjure up images of 'natural remedies' and 'plant extracts' and remember hearing that there are no side effects associated with homeopathic medicines. The reason that there are no side effects is because you are lucky if there is any active ingredient whatsoever in the 'medicine'.

Homeopaths believe that if a substance causes an effect, then a small dose of that substance can cure an ailment with the symptoms that match that effect. For example, *Strychnos Ignatia* causes people to suffer feelings of grief, so a small dose of the Ignatia tree is apparently a cure for grief. This 'like cures like' argument sounds plausible enough when you consider vaccines, where a small amount of a virus (or virus-like particle) is administered to allow your body to learn how to fight against it. Alas, that is where the similarity to conventional medicine ends.

Homeopathic products are sold in terms of their strength. Your local homeopath will sell Ignatia, for instance, under a name like 'Ignatia 30C'. The word 'Ignatia' implies, unsurprisingly, that this ingredient is in the thing you are buying (a good start) and the '30C' term tells you the strength, or rather the lack thereof. You may think 'the higher the number, the stronger the dose', but you would be wrong, worthless human! Take your logic elsewhere. '30C' is a measure of dilution so the higher the number, the more diluted the initial product is. In this case, it means that 1ml of the Ignatia extract (or 'active' compound) has been effectively diluted into 10^{54} cubic metres of water. That's a cube of water where each side is 106 light years in length, which is bigger than our solar system. This means that a whole bottle of Ignatia 30C is statistically unlikely to contain even one molecule of Ignatia extract, and the higher the dilution, the less your chances are of – maybe – getting that one molecule that probably wouldn't treat your illness anyway. For comparison, a 200mg ibuprofen tablet contains around six hundred million trillion molecules of ibuprofen. Homeopathic tablets are also available, but here just one drop of the homeopathic solution is added to a little ball of sugar, diminishing your chances even further of getting any of the active ingredient. There is a good reason why you cannot overdose on homeopathic pills. The worst you are likely to get is a dental cavity.

So, given that homeopathic remedies are a few gazillion molecules short of a medicine, how do homeopaths justify ripping people off? Well, they use a highly scientific process called succussion (invented by Samuel Hahnemann). After each dilution the homeopath hits the mixture with an 'elastic body', often a book (fiction/non-fiction, all genres are acceptable), to imprint the 'memory' of the homeopathic remedy into the surrounding water. Modern-day homeopaths still cite the theory from 1988 that water has a memory of what has been in it before. Despite being roundly debunked by the journal Nature[3], and despite a grand total of zero studies being able to provide evidence of water's memory, and despite the fact that the notion is just plain stupid, homeopaths worldwide have kept calm and carried on regardless in The Great Dilution Swindle.

Our problem with homeopathy is not one that can be criticised as being scientific elitism. This is common sense elitism – an elite that, frankly, everyone could easily be a part of. We live on a planet where the environment is governed by the hydrological system. Water evaporates continuously from the oceans, forms clouds, precipitates as rain and makes its way into the water system until it eventually pours out of your tap. If water had a memory, surely it would remember, for example, the fish? Since sufferers of seafood allergies have a horrible reaction to, say, lobster, the homeopathic approach would

dictate that we give them a 'small dose' of the pesky thing, or the water that remembers him to be more precise. Yet people with shellfish allergies, who at some stage we assume will drink water, can still have lethal reactions to a plate of lobster bisque.

Of course, this is all well and good – lampooning homeopathy for fun – but why do we care? Well, we do and we don't. Most of the time, homeopathy is amusing nonsense. Since no actual scientific evidence exists (despite innumerable attempts) that proves the efficacy of homeopathic remedies, homeopaths rely heavily on cherry-picked results, anecdotal evidence and testimonials from die-hard homeopathy fans. Familiar sentiments are usually displayed on homeopathy websites: "I tried everything to treat my cold/flu/diminished brain capacity but nothing worked, and then I tried this homeopathic shit and it worked like a boss". We're paraphrasing, obviously, but you get the GIST.

This does pose an ethical dilemma: even though homeopathic remedies work by the placebo effect alone, can the fact that some patients feel better justify the use of homeopathy? We don't believe it can. There is most definitely a point where the amusing nonsense becomes dangerous misinformation. Since most homeopaths have no medical training and do not understand medical diagnoses, there are many examples of homeopaths offering treatment for serious illnesses which a placebo cannot cure: travellers foregoing conventional malaria treatment in favour of homeopathic remedies, for instance, with some horrendous consequences[4]. Frighteningly, there are even homeopaths claiming to be able to treat cancer[5]. Believers in homeopathy may be wilfully ignorant or they may be gullible, but as much as there is a line between the two there is a line between inefficacious flu remedy and inefficacious cancer treatment – a line we don't think should need to be drawn. Homeopathy is the beginning of a slippery slope to abandoning reason and rationality in medicine. The moment we ignore evidence (or plough on despite evidence) is the moment science is lost to medicine, and the moment we as a species take a(nother) step backwards.

Unfortunately, there's not much that one person can actually do about it. You can refuse to buy these products but the problem is that homeopathy is more a belief system than anything else. Jeremy Hunt's views were brought to light in his reply to a constituent stating that they'd have to 'agree to disagree' on the matter. This gets to the very heart of the problem; once people hold a view-point, they rarely abandon it. Challenging an entire belief system is not an easy thing to do. We're not even sure how one can reasonably go about doing it without becoming a shouty science extremist. The best we can hope for is that science education continues to reach further and wider, that the layman understands the importance of the scientific method and that this stagnation of reason that has manifested itself in the 21st century is only a temporary hiccup in human evolution.

As we mentioned earlier, the recent cabinet re-shuffle brought to our attention that some MPs, not to mention MSPs and certain members of the Royal Family, hold the view that homeopathy is good. Not only do they hold this view privately, but they publicly defend it – and defend it defiantly in the face of reasonable evidence. These people have influence; indeed, Jeremy Hunt essentially now runs the NHS. Furthermore, with the refusal to publish the private letters of Prince Charles to MPs we're only left guessing how this problem is being dealt with behind-the-scenes. Is homeopathy being slipped in through the back door of the NHS? Or rather, is the door being opened wider? Rt. Hon. Jeremy Hunt MP, the UK Secretary of State for Health, supports homeopathic care. Sleep well.

// Scott McKellar and Craig McInnes are chemists and rational thinkers who provide an undiluted version of their opinions.

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by Beverley Caie

GLASGOW – LIVE FAST, DIE YOUNG

// GALLOWGATE TOWERS

Highest residential structures in Scotland, located in the East End of Glasgow.

These will be demolished in the near future, due to their unpopularity with residents and high maintenance costs.

David Houston & Courtney Gunn

David Iain Houston shines a light on Glasgow's shocking health record and explores a recently discovered phenomenon known as the 'Glasgow Effect'

Its 2013 and we live in Glasgow – one of the westernmost cities in one of the westernmost countries in Europe. Stark it is then, when you consider that the life expectancy of a man in the East End district of Calton is 54, while in more affluent areas like the North Glasgow suburb of Lenzie male life expectancy rises to 82. It is hard to avoid making comparisons with war-torn states like Iraq and the Gaza strip where male life expectancies are 67.5 and 70.5, respectively.

Historically Scotland's status as the most unhealthy country in Western Europe has been attributed to its higher levels of socio-economic deprivation. Recently however researchers have observed a 'Scottish Effect' where Scotland has been compared with similarly deprived populations and discovered that we Scots live significantly shorter lives despite sharing very similar health factors and employment rates. These higher than expected morbidity and mortality rates are present across the country as a whole – not just in all geographic regions but across all levels of the wealth spectrum. No more so is this effect evident than in the metropolis of Glasgow, with male life expectancy 72 and female life expectancy 78 compared to Scottish life expectancies of 76 and 80, respectively.

Glasgow's industrial rise to power in the 19th century as the engine of the Great British Empire, followed by its almighty fall from grace in the de-industrialisation which took place during the latter half of the 20th century, left a city scarred by: mass-unemployment; urban decay; population decline; welfare dependency; and the knock-on health effects. In today's Glasgow, decades of urban regeneration has resulted in higher employment rates than the likes of Manchester and Liverpool – very similar cities with respect to a shared history of industrialisation and de-industrialisation and similar levels of deprivation. However, in the Scottish city, the far higher rates of morbidity and mortality than can be explained by deprivation have led public health groups to explore a phenomenon known as the 'Glasgow Effect'.

In a 2010 study[1] carried out by the Glasgow Centre for Population Health (GCPH) the health of Glasgow was compared with that of Liverpool and Manchester. Mortality and population data were collected from national survey agencies over a five year period from 2003–2007 in order to generate a series of standardised mortality ratios (SMRs) for Glasgow relative to Liverpool and Manchester pooled together. Each city was split into multiple neighbourhoods – 350, 291, and 251 in Glasgow, Liverpool, and Manchester respectively – each with a population in the region of 1600. Within each neighbourhood 'income deprivation' – a measure of the proportion of the population reliant on income-related benefits, including children dependent on adults who are in receipt of these benefits – was used as a reliable index of overall deprivation.

Deprivation was almost the same for the three cities, with just under a quarter of the total populations defined as income deprived. Despite extremely similar deprivation profiles overall mortality was 14% higher in Glasgow than Liverpool and Manchester. Mortality in Glasgow for premature death (<65 years) was 31% higher relative to Liverpool and Manchester.

Glasgow's 'excess' in mortality was most prevalent in the 15–44 age group which had 46% higher mortality than in the equivalent group in the two English cities. Across most ages SMRs were considerably higher for comparisons of deaths among males.

The SMRs for each deprivation decile (each cities' total population was split into 10 equal groups based on their income deprivation) were also calculated for each of the three cities. When considering all deaths, Glasgow had consistently higher mortality rates across all deprivation deciles with 19% 'excess' mortality in the most deprived decile (decile 10) but also 15% 'excess' mortality in the least deprived decile (decile 1). When premature deaths are considered, this 'excess' mortality seen across all of Glasgow's deprivation deciles increases significantly where those represented by the most deprived deciles are the worst affected.

The study further analysed different causes of death. SMRs for the most common causes of death – all cancers (except lung cancers) and diseases of the circulatory system including heart disease and strokes - were similar to the SMRs calculated for all Glasgow deaths, however SMRs for other causes of death reveal much higher 'excesses' relative to Liverpool and Manchester. These 'excesses' were 27% higher for lung cancer; 32% higher for external causes, including murders; 68% higher for suicide; 230% higher for alcohol related deaths; and 249% higher for drug related poisonings.

From 2003–2007 'excess' deaths in Glasgow relative to those expected based on similarly deprived cities in

North West England amounted to 4500; of which 2090 were in the <65 age group with around half of those in the premature mortality range dying from alcohol (32%) and drug-related (17%) causes.

By looking at historical trends in premature mortality data for the three cities researchers in this study show that the 'Glasgow Effect' is a recent phenomenon, with increases in excess mortality in Glasgow relative to Liverpool and Manchester first appearing in the 1980s and widening over a 30 year period to present day levels.

So if a 'Glasgow Effect' is indeed at play, are the causes known and can they be counteracted?

In truth, there are a great many unknowns surrounding the causes of the 'Glasgow Effect'; the next stage of the GCPH's investigation will look at qualitative data, which will delve deeper into the differences in mortality between cities with seemingly identical socio-economic deprivation.

While income deprivation appears to be a reliable marker for overall deprivation, it is possible that there is a failure to pick up certain nuances that may be specific to Glasgow's deprivation. Saying that, in the GCPH study Glasgow proved to have similar numbers of smokers, binge-drinkers and drug users; as well as having similarly poor diets and levels of obesity as Liverpool and Manchester. There are numerous potential explanations for the 'Glasgow Effect' including: extremes in substance abuse not detected in routine health surveys; genetic factors; a culture of boundlessness and alienation; low social capital; a background of rapid de-industrialisation; limited social mobility; sectarianism; a sense of political abandonment particularly during the Thatcher years; poorer access to healthcare; and poor parenting and early years development. Perhaps a number of these factors act in concert to give Glasgow that certain *je ne sais quoi.*

Although the causes behind the 'Glasgow Effect' are much debated, a picture emerges from the GCPH study and many other studies carried out over the last decade where populations with the greatest inequalities in wealth have the highest levels of social and health problems. At the 2011 TED Global conference in Edinburgh, Professor Richard Wilkinson presented research[2] which conclusively shows a fascinating paradox: in the comparison of developed nations there is no relationship between how wealthy a country is in terms of average gross income per head and its index of health and social problems; however when comparing the same developed nations there is a clear correlation between income inequality within countries and their index of health and social problems whereby countries with the greatest income inequality have the most severe health and social problems. Whatever amplifies the 'Glasgow Effect' is not clear, however, what is evident is that the most direct and effective way to tackle poor health and social deprivation in the Western world is to narrow the gap between how much the poorest and the richest earn in our societies.

// David Iain Houston is a 3rd year PhD student at the University of Glasgow.

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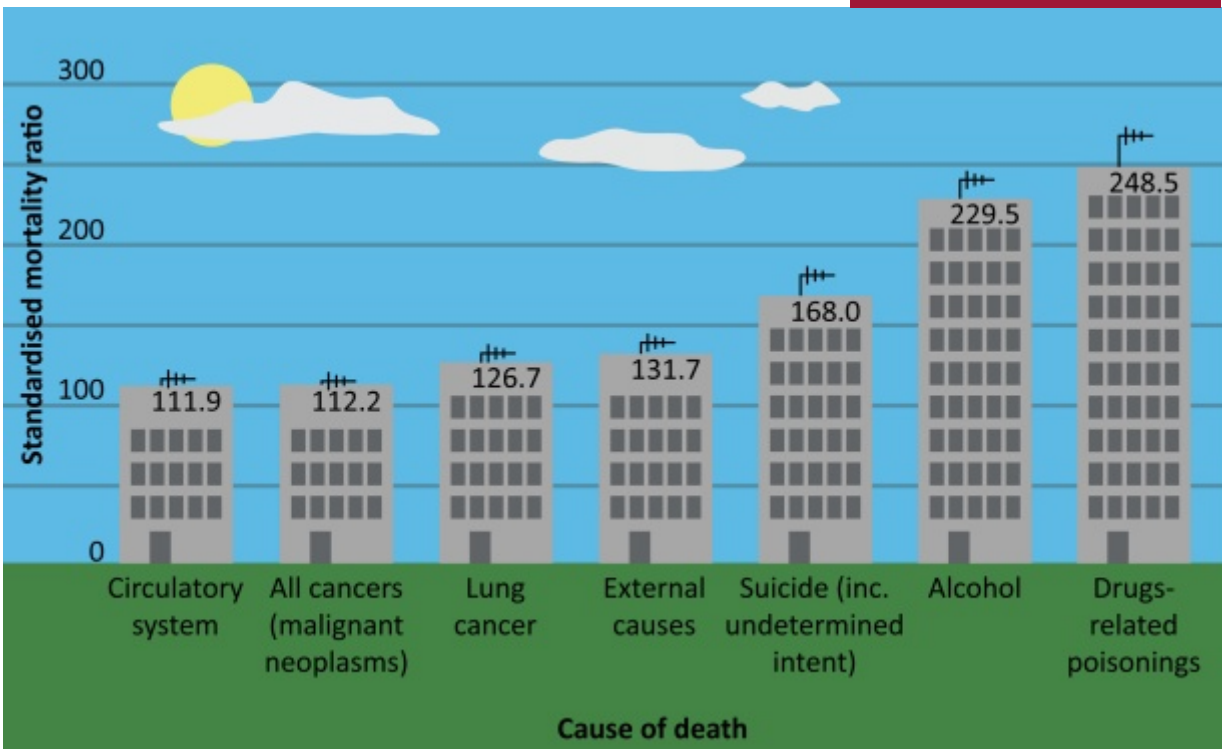
CAUSES OF DEATH

Standardised mortality ratios 2003–07; all ages, all sexes; Glasgow relative to Liverpool & Manchester; standardised by age, sex and deprivation decile



David Houston & Johnny Stormonth-Darling

CSI BECOMES REALITY

Welcome to CSI: The Hague

Yumi Kimura (Wikicommons, CC 2.0)

Felicity Carlysle experiences a place where fact is cooler than fiction.

CSI: The Hague

As a forensic science student I am naturally suspicious of anything with CSI in the title. While the TV show (and its assorted spin-offs and variants) has done wonders to boost the profile of the forensic science profession, it has also had a detrimental effect by creating unrealistic expectations – the so called 'CSI effect'. Therefore when attending the European Academy of Forensic Science (EAFS) conference I took the title of the workshop "CSI The Hague: To the crime scene"[1] with a pinch of salt. However what I saw blew me away, and demonstrated what can be achieved when a government and private companies come together with a common goal.

So what is CSI The Hague? The Netherlands Forensic Institute (NFI) has brought together a conglomerate of technological companies to bring crime scene examination well and truly into the 21st century. This three year project has two aims, developing new and cutting edge equipment for use at crime scenes, and developing innovative new ways to train not only crime-scene examiners but also first responders so as to increase the useable evidence collected, in particular, minute traces which are otherwise easily missed or accidentally destroyed. This has resulted in the creation of a mock street, complete with fake tulips, and some technology that surpasses that imagined by the creators of the TV show.

A digital crime scene

One of the primary aims of the project is to develop novel methods for crime scene examination. The main way that CSI: The Hague has decided to approach this is through digitising the crime scene. This means that while the scene can only be investigated once, data from the crime scene can be re-examined, and furthermore evidence that might be missed by a human could be detected using a machine. 3D rendering of the scene, augmented reality glasses, a device to scan a room for bloodstains, it all sounds a bit science fiction but CSI: The Hague has made it a reality.

Who'd have thought an Xbox Kinect could help solve crime. CSI: The Hague has developed a system using an Kinect sensor linked to a computer to produce 3D imaging of a crime scene, complete with accurate distance measurements and angle calculations. It is also possible to place virtual markers on the image rather than placing markers on the crime scene. What's more it can be done within minutes, leaving plenty of time for a game of Let's Dance!

CSI: The Hague has developed augmented reality glasses for use at crime scenes. Despite being no larger than a pair of sunglasses, these glasses allow you to record what you view, bring up information on items using hand controls and speak to other experts who aren't at the scene. While they may not be the height of fashion these glasses are certainly a cool piece of kit.

How many of us have been fooled by the old fake blood trick? It is amazing how at a quick glance many red liquids can look like blood, so imagine the challenge for crime scene investigators to figure out what is and what isn't blood at a scene. In step CSI: The Hague with their fantastic new instrument which can not only distinguish between blood and other red coloured stains it can also give an approximate age for a bloodstain allowing investigators to differentiate quickly between blood evidence relevant to a case and blood that has been at the scene

for a long time. So no more chasing after a person who wasn't involved but was unfortunate enough to have a nosebleed at the scene two weeks prior to the incident!

So how does this miracle scanner work? The theory is actually pretty simple, and is all to do with what happens to oxygenated haemoglobin as it breaks down. Haemoglobin is converted to two chromophores, met-hemoglobin and hemichrome, and this results in a subtle colour change to a blood stain. The system, developed by Forensic Technical Solutions, is a spectral imager. It uses the absorption of light to determine the chemical composition of suspect stains, as different chemicals absorb different wavelengths of light. This means blood at different stages of decomposition will produce a different absorption spectrum, and compounds that are not blood such as lipstick or red paint will also produce a different spectrum. The means that the technique is non-destructive and the results are virtually instantaneous. In addition the technique can be expanded to other bodily fluids using the breakdown of specific proteins within them.

Forensic Technical Solutions have taken measurements of blood stains as they age in order to determine the concentration of the chromophores present at each time period. This means they can now determine how old a bloodstain is based upon the chromophore concentration.

Fake tulips and serious gaming

CSI: The Hague and its 'innovation lab' is hidden away inside the NFI field lab. The main area is set up to allow for testing of the new kit, and training of scene examiners and first responders. There is a briefing room, an observation room and then the mock street with a three roomed house – bedroom, bathroom and kitchen/living area.

The briefing room does exactly what it says on the tin, in here the trainees are briefed on the scenario before being let loose on the scene. The observation room is where the trainees are monitored during the exercise, with cameras in all areas and also motion capture panels on the ceilings which enable the mapping of the movements around each room. This means that it is possible to see which areas of a room a scene examiner spent most time in, and if they covered all of the area. The heart rate and temperature of the trainees is also monitored. Finally the video taken from each room can be annotated to note errors so that the trainees can be fully briefed on their performance afterwards. Also in the observation room is a computer dedicated to creating realistic crime scene scenarios which are then set up in the house. This takes away any bias from the teacher who may well be experienced in one particular type of crime scene and so have taught this in far more detail to the trainees.

The mock street and house are where all the action happens. The street has two projection screens at either end for 'serious gaming', and the house itself is fully kitted out with all the clutter you would expect plus, of course, a crime scene.

It is a reasonably well known fact that much of our learning as small children comes through play, and at CSI: The Hague they have realised that this can also apply to adults. Serious gaming is the term used for virtual learning programs created to help train scene examiners and first responders. For obvious reasons new trainees cannot be let loose on a real crime scene, therefore what is effectively a video game on a larger scale can provide some much needed training. While this cannot beat hands on training, the immersive virtual environment comes a close second, with the definite advantage that mistakes do not have significant consequences. This system can be particularly useful for training of first responders, primarily members of the emergency services, who are unlikely to have any forensic experience. While looking for forensic evidence is not the role of the first responder, an awareness of forensic can help the preservation of evidence for collection by investigators when they arrive.

Coming to a crime scene near you

So it turns out science fiction can become science fact, all it takes is a co-ordinated effort between the government, forensic scientists and technology companies. Many of the technologies at CSI: The Hague are at the validation stage, and the Forensic Technical Solutions blood detection system has already been used in some forensic investigations in the Netherlands. The success of the project means that it is likely that the technology will be sold to other countries and hopefully similar projects will be started across the globe to further improve the technology and training available for crime scene examiners. So keep an eye out as CSI: The Hague may be coming to a crime scene near you.

// **Felicity Carlysle is a 3rd year Forensic Chemistry PhD student at the University of Strathclyde.**

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Netherlands Forensic Institute

// AUGMENTED REALITY GLASSES

Although not very fashionable, the high tech glasses are incredibly handy with their camera, heads-up display and inbuilt communication system.

COMPRESSED SENSING

Paul McCool investigates advanced image processing techniques.

Every time data is transferred between a digital device and the outside world, it is subject to digital signal processing, or DSP. In other words, DSP is in virtually everything these days. When you talk into your mobile phone, the microphone converts your voice into an electrical signal. The voltage of the signal is measured many times a second and converted into binary numbers, in a process known as sampling. The amount of data generated depends on how often measurements are taken, known as the sample rate. The sampled signal is then compressed, transmitted and reconstructed as a representation of your voice through the loudspeaker at the other end.

The digital representation of your voice is not very precise because mainly because of the sampling process. This does not matter so much for phone calls: you only need to be understood at the other end and sound quality is a secondary concern. A mobile network is a finite resource, so how low a sample rate can a mobile phone operator get away with before your voice becomes unintelligible?

In the 1920s, an engineer called Harry Nyquist discovered that the minimum frequency at which a signal must be sampled is twice the maximum frequency present within the signal, otherwise distortion known as aliasing can occur, in which higher frequencies masquerade as lower. The Nyquist Sampling Theorem is so important that the first question that DSP engineers ask when designing a new system is "what's the sampling rate"? For example, compact discs have a sampling rate of 44.1kHz because it is slightly more than double the 20kHz limit of human hearing. The human voice has a limited frequency range so the sample rate need only be 8kHz for phone calls.

It turns out that it is possible to get around the Nyquist theorem, at least in some cases. In the 1980s, seismologists realised that they could detect geological phenomena in their data that should not have been possible. They had stumbled on something that was not mathematically analysed until 2004, when Terence Tao and Emanuel Candès working at the California Institute of Technology were wondering whether a digital camera could take a photo and only gather the amount of data equivalent to the compression ratio that the JPEG image standard could achieve. Tao soon calculated that this would indeed be possible in certain circumstances, and so 'compressed sensing' was invented.

Imagine a black-and-white digital camera sensor. The sensor is effectively a rectangular array of small square sensors, each of which generates a number based on the amount of light it receives through the lens. These are the pixels, and the number represents the shade of grey of the pixel.

Now instead of taking a conventional image using all the pixels at once, we choose a few random pixels from across the sensor and sum their values. This is done a few times with different random groups of pixels. We now have a set of equations that can be solved mathematically to show, with strong probability, what the entire image across the sensor must have been.

You might have recognised that there is little point in having all those pixels on the camera sensor and then not using most of them most of the time. A method of summing up the totals for each group of pixels would do the same job. The Single-Pixel Camera from

Johnny Stomonth-Darling

// By capturing and summing groups of samples through known random masks (left), compressed sensing enables a near perfect image reconstruction (right) from this sparse data set.

Rice University works in exactly this way: a single sensor is used, and a mask is used to represent the random pixel pattern.

For this to work properly, the signal must be 'sparse'. A sparse signal is one that has most values the same or zero. It turns out that most signals are sparse in some way. For example, a picture taken outdoors might have mostly blue sky, or an audio sample might have only a few frequencies present. Compression techniques such as JPEG and ZIP files already take advantage of signal sparseness to compress data, but it is mathematically intensive. Compressing data as it is collected, as compressed sensing effectively does, reduces complexity and therefore lowers cost and power consumption at the sensing end. This is useful, for example, for making sensors out of exotic materials to work in different wavelengths. The trade-off is greater complexity at the processing end.

Compressed sensing and its mathematical toolkit are already being developed for use in many fields such as radar, medicine and astronomy. You will benefit from it when you go for an MRI scan, or curse it when a compressed sensing radar is hunting your fighter jet. The author speculates that it will eventually augment the abilities of consumer devices like digital cameras, so maybe in a few years you will be showing off the new single-pixel infrared camera in your mobile phone.

The Optics Group in University of Glasgow's Physics Department is developing an imaging system that uses Compressed Sensing, called Computational Ghost Imaging, which uses a Spatial Light Modulator to generate and record the random patterns of light that are needed for the Compressed Sensing principle to work, instead of the camera and mask.

// Paul McCool is currently pursuing a PhD in electronic engineering at the University of Strathclyde.

// Thanks to Dr Matthew Edgar, Optics Group, University of Glasgow for information about Computational Ghost Imaging.

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// ESOTERIC PROGRAMMING LANGUAGES

Esoteric programming languages are designed to test the boundaries of computer programming language design, as a proof of concept, or even as a (bad) joke. Steven Davies presents some of the most noteworthy.

// An example of whitespace programming... Mmm, check out that syntax.

Alan Boyd

INTERCAL

The granddaddy of esoteric languages, INTERCAL – or Compiler Language With No Pronounceable Acronym to give it its full name – is famous for its humorous manual and silly operator names like rabbit-ears ("), wow (!) and ampersand (&). Enforcing the kind of politeness your mum would be proud of, the initial implementation was sadly only capable of outputting roman numerals. Later implementations would introduce text output as well as sidestep all the problems of GOTO in other languages with the revolutionary COME FROM instruction, and were capable of pretty much anything you could do in another language. Just as long as you remember to ask politely.*

*** But not too politely of course.**

Malbolge

A language so difficult it allegedly took 2 years to actually write the first program in, Malbolge is more cryptographic puzzle than programming language. Self-modifying instructions, ternary number systems and the aptly-named crazy operator all combine to transport anybody foolhardy enough to attempt programming in Malbolge to the circle of hell the language is named for. And yet somehow several people have managed to create, or perhaps conjure, versions of Hello World, and even a strangely hypnotizing version of 99 Bottles of Beer. Of course, if you're not feeling quite up to tackling writing Malbolge by hand you could cheat by using a compiler to translate another language into Malbolge. It's just a pity the other language is Brainfuck...

Whitespace

Without a doubt the most elegantly minimalist programming language ever developed, every command in Whitespace is made up of just three tokens: , and

Since all other characters are ignored Whitespace is ideal for literate programming. It's also fully independent of any natural language so is perfect for globally distributed development. It's also great for any companies required to keep hard copies of their code, but that still want to keep their ink costs down. There's only really one disadvantage to Whitespace: since it's an interpreted language it's not suitable for tasks requiring high-performance.

// Steven Davies is a PhD student studying software engineering at the University of Strathclyde.

E=MC²
WHO'S EQUATION IS IT ANYWAY?

Tim Revell rediscovers some of the forgotten names associated with the world's most famous equation.

Lienhard Schulz (Wikicommons, CC 3.0)

// Probably the most famous equation in human history, the mass-energy equivalence is universally attributed to the equally famous Albert Einstein. But was Albert really the only man behind the maths?

In the introduction to Stephen Hawking's "A Brief History of Time" he says that his publisher told him that every equation he included in the book would cut its sales figures in half. He included only one equation and that was $E=mc^2$. This equation – also known as the mass-energy equivalence – is probably the most famous equation in all of science. It states the fundamental relationship between mass (m) and energy (E) – that they are related by the speed of light squared (c^2).

Under the right circumstances the equation allows for energy to be converted into mass (or vice-versa) and c^2 is the exchange rate. The process of converting mass into energy is how stars (including our sun) produce light, heat and all of the different elements that we find elsewhere in the universe. This includes all of the atoms that make up our bodies, our planet and our solar system. In the words of Moby, "we are all made of stars".

The importance of this equation (and especially the theory behind it) is substantial and well publicised. Its applications affect our lives on a daily basis in areas ranging from GPS to carbon dating. The credit for this equation is generally attributed to one man – Albert Einstein.

In science there are normally two ways to make your name synonymous with an equation – either be the first person to state it or the first person to correctly reason why it is true. Since this equation is most associated with Albert Einstein, which of these did he do? The answer, surprisingly, is neither.

In 1717 Isaac Newton wrote, "Are not the gross bodies and light convertible into one another, and may not bodies receive much of their activity from the particles of light which enter their composition?" in his book Opticks[1]. Here he suggests that a mass-energy equivalence exists. Of course this is not the same as giving the equation, but the seeds had been sewn some time before Einstein's first paper on relativity, “Does the Inertia of a Body Depend Upon Its Energy Content?” in 1905[2]. Towards the end of the 19th century and the beginning of the 20th century much work was being done on electromagnetic radiation. J. J. Thompson (1885) suggested that the energy of electromagnetic waves corresponds to a certain mass. O. Heaviside (1889) and H. Lorentz (1904) also published work relating to this idea, but it is the work of H. Poincaré (1900) and later F. Hasenöhrl (1904) that first show the equation $E=mc^2$.

"we are all made of stars"

Henri Poincaré was a very gifted French scientist; he made significant contributions in pure and applied mathematics, physics and philosophy. In 1900 Poincaré published a paper deriving the equation $E=mc^2$. He arrived at the result by describing electromagnetic radiation as a fluid. However, he did not believe that his result suggested that mass and energy were interchangeable but that he had discovered a sort of "recoil effect". This interpretation is now known to be incorrect but his equation still stands. Following on from this, in 1904 Hasenöhrl managed to derive that E was proportional to mc^2. Although he couldn’t derive a correct expression for this relationship, he was out by a factor of 3/8, he did deduce that energy and mass were equivalent. The work of Poincaré and Hasenöhrl was in some ways incomplete, neither managed to produce a rigorous argument as to why the equation $E=mc^2$ should be true[3]. Einstein managed to add to this work, but subsequent investigations have shown that he also was unable to provide a rigorous explanation.

The first of Einstein's attempts to derive the mass-energy equivalence was deemed by Herbert Ives in 1952 to be "begging the question". This is a term that is used in logic to describe the situation when one uses the conclusion to deduce the conclusion. For example if we assume that everyone in Glasgow drinks whisky then we can conclude that everyone in Glasgow drinks whisky. The inference made in this statement is clearly true even if the premise is not. Essentially Einstein’s proof used the argument $E=mc^2$ – just because. Therefore Einstein’s derivation was not logically sound and hence incorrect. In the 2008 paper "Einstein's $E=mc^2$ mistakes" by Hans C. Ohanian every derivation of $E=mc^2$ that was produced by Einstein throughout his life was meticulously assessed. The paper states that all of Einstein’s derivations suffered from mistakes, including logical blunders and unrealistic approximations[4].

The story so far might cause one to lose some faith in brilliance of Albert Einstein, but despair not. Einstein may not have been the first to suggest the mass-energy equivalence nor was he the first to produce a correct derivation, but his name has become synonymous with this equation and for good reason. Einstein's works on relativity provided beautiful insights into the world of physics that had not been fully realised before he became involved. He may never have produced a perfectly structured argument as to why $E=mc^2$, but he certainly came close. As is the way of science he built on the work of others, using their understanding to advance his. The great man only had a basic knowledge of the physics of his time and it is generally accepted that he had not read many of the works mentioned in this article.

Einstein was also a brilliant conveyor of science; he was able to promote his subject in a way that engaged not just physicists, but also the public. He travelled round the world presenting his ideas. In Tokyo an impromptu talk turned into a four hour lecture due to the demand from the thousands that had come to hear him speak. He captured the imagination of those who read his work or heard him speak and made great contributions to his field. His popularity can be considered one of the main reasons why his association with $E=mc^2$ is so well known compared to the others involved in the discovery. Einstein was a genius, arguably the greatest physicist (if not scientist) to have ever lived, but it should be remembered that he was not the only person involved in the discovery of the remarkable equation $E=mc^2$. Let the final thought of this article be from Einstein himself: "A person who never made a mistake never tried anything new"[5].

// Tim Revell is currently studying for a PhD in computer science at the University of Strathclyde.

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// Albert Einstein's signature (Can anyone see the 'E'?)

Scewing (Wikicommons, Pub. Dom.)

// FROM MARS TO CALLISTO

Unless you live under an impressively sized rock, you will have heard of the recent landing of NASA's Curiosity Rover on Mars. But what are the possibilities for human exploration beyond the Red Planet?

As the rover Curiosity continues to send back a wealth of fascinating data, and possibly evidence that Mars once harboured life, it is only natural that we begin to think forward to the possibilities of human travel to the Red Planet and beyond. There are many who believe that we should be well on our way to Mars already[1], but for whatever technical, financial or political reasons we are still decades away from achieving that milestone in human exploration. Nevertheless, the thought of human colonisation of Mars opens our minds to the other amazing places within our solar system that human feet may one day take their first steps.

For example, imagine looking up at the sky from Callisto, Jupiter's furthest Galilean moon, and seeing before you not only the awe-inspiring gas giant dominating your view, but also the transient masses of the other Galilean moons Io, Europa and Ganemede. A human base on this distant rock is not entirely out of the question and it has been considered as a potential location for a human outpost for the exploration of Jupiter's other moons and the further reaches of solar system[2]. Both Europa and Callisto show evidence for the presence of liquid water beneath their surfaces and oxygen in their thin atmospheres, making them possible candidates for harbouring life. While Ganemede's larger size (twice the mass of our moon) might make it more gravitationally comfortable for humans, Callisto's greater distance from Jupiter's radioactive emissions make it somewhat safer in that regard... and the view is better.

Sadly, despite our collective human desire for adventure, and the fact that even now all this is largely within our grasp technically (and will only become more so), it will take a suitable political climate and the right financial incentives before any lucky astronaut will have the pleasure gazing up at that Jovian sky for the first time.

NASA (Public Domain)

// Quite a view, eh?

// Johnny Stormonth-Darling is a PhD student at The University of Glasgow studying nanofabrication.

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SILK, SEX AND DECEPTION:
THE SECRET LIVES OF SPIDERS

Emily Fountain

// SPIDER SILK

Most spiders produce silk to create beautiful webs. The style of the web depends on the kind of spider and the use of the web. Recent research has been looking into creating spider's silk for industrial purposes; as an alternative to glass and plastic. Some silk is ten times tougher than Kevlar.

What do Justin Timberlake, Ron Weasley and Kim Kardashian have in common? They are all afraid of spiders, like many other people. But why? Spiders lead perilous lives and are much too busy saving their own skins to go after humans. These animals are fascinating and useful, and those who suffer from Miss Muffet syndrome are missing out. In light of the recent bee craze, where the plight of the UK's stinging furballs has called the British public to arms, I would like to celebrate our new-found love for the many-legged by ensuring that spiders receive some positive media attention, for once.

When faced with a horrifying situation in which somebody is about to purposefully squash a spider, most arachnophiles give the usual spiel about spiders being useful agents for the control of household pests. It is true that spiders catch other invertebrates such as beetles and flies, and can be good at controlling agricultural pests[1]. They also control dangerous insects that spread diseases such as malaria[2]. But the virtues of spiders extend far beyond their hunting proficiency.

Some spiders have venom with a low molecular weight which could be used in medical research and drug development[3]. Spider silk is researched intensively due to its incredible strength and elasticity. It is the toughest known biomaterial: silk from Darwin's bark spider is ten times tougher than Kevla[4]. Silk is currently being discussed as an alternative to glass and plastic in high-tech optical equipment, due to its recently discovered light-manipulating capabilities. Potentially, future medical instruments may use spider silk, making some medical procedures, such as internal sensing and imaging, less invasive, less expensive, and more eco-friendly. Through genetic engineering it is now possible to mass-produce the amazing properties of spider silk using modified silkworms and bacteria, but let's not forget that spiders made it first.

Spiders are everywhere, all the time. You may not always see them, but that is not surprising given their usually small size. Inside your home you may occasionally see the friendly face of *Tegenaria*, the leggy corner-lurker and regular bath spider. Female *Tegenaria* can grow to gargantuan proportions by UK standards, with bodies up to 18mm long. The males are smaller and more timid, as you would be if you had to mate with something twice your size. If you look at a male closely you will see that he sports a pair of appendages at the front whose tips are swollen like boxing gloves; these are his sex organs. His aim in life is to thrust these ungainly but beautifully elaborate structures into the epigynum of a female, which is located on the underside of her abdomen. To do this he must

get past her fangs. He is the invertebrate version of St. George, except that the dragon and the princess are the same character.

All around the world, male spiders face situations that could lead to sex or suicide (and sometimes both). Many go to elaborate lengths to ensure their survival. Self-respecting jumping spiders, for instance, will parade spectacular costumes in startling dances[5]. Others will sing their female a seismic song. Wolf spiders can sing and dance[6], a touching performance considering they make a living from hunting other spiders. It isn't all about self-preservation, though: spare a thought for the brave male redback, who gives his life for his babies. Upon finding a mate, seducing her by plucking out special rhythms on her web, and penetrating her epigynum, he somersaults, exposing his juicy abdomen which she then devours[7]. His gallant sacrifice gives the female nourishment which appears to help their offspring develop. If, however, the female was impressed with her mate's effort in courtship, she may spare him.

Female spiders may be a little unforgiving as far as relationships go, but they are not all bad. Some are attentive mothers, carrying their young piggy-back and even producing droplets of food for them. Females are typically longer lived than males, and are also usually bigger and more spectacular looking – and believe me when I say that spiders know how to do spectacular. *Nephila*, for example, are brightly-coloured spiders the size of your hand. They spin complex golden webs over a metre across, and have been reported catching birds and even snakes.

The largest spiders belong to the *Theraphosidae*, or tarantula family. These ancient spiders can have huge fangs and look monstrous, but their bites are not lethal except where an allergic reaction occurs. The more commonly kept tarantulas of the Americas, such as Mexican red-kneed tarantulas, are generally docile and would rather run away than bite. However, they do have another trick to get would-be predators off their backs: they can flick specialised hairs into the air, which stick in the skin and itch like crazy.

European, Australian and Asian tarantulas are a little different. They can be pretty feisty but their venom is not lethal. There are some breathtakingly beautiful species, such as the Gooty sapphire which has a vivid blue body and white blaze markings.

Other spiders are less conspicuous. You will probably have noticed small, brown spiders that hide under rocks and in crevices, and all spiders (particularly pet tarantulas) seem able to squeeze themselves into impossibly small spaces. Australian bark spiders live on tree trunks and are well camouflaged, with flattened bodies to avoid being detected by predators. If you put your hand on a tree near a bark spider, it will spring into life, zipping around the trunk with incredible speed, somehow maintaining its flattened profile.

However, some spiders go a little further towards disguising themselves. Thomisus, a crab spider, is so good at being a flower petal that you would have to know it was there before you (or a predator) noticed it. To an insect, on the other hand, the spider appears conspicuous, glowing tantalisingly with ultraviolet light. The presence of *Thomisus* in a flower makes its insect prey more likely to visit that flower, with gory consequences[8]. Still more impressive are ant-mimicking jumping spiders, which really do look like ants, and even wave their front legs in the air, pretending they are antennae. One species has been documented helping its adopted ant colony build their nest, adding some nice warm silk to the structure[9]. Spiders can make friends too.

The next time you see a little spider, think twice about how you react. His life is hard enough as it is without you throwing him out into the cold or stamping on him, and doing so will not significantly reduce the number of spiders in your house. He is only after dinner and a girl, and has his work cut out already. You can just, you know... look the other way.

// **Victoria Smith is currently studying for her MSci in Zoology at the University of Glasgow. Her interests include arachnology and conservation.**

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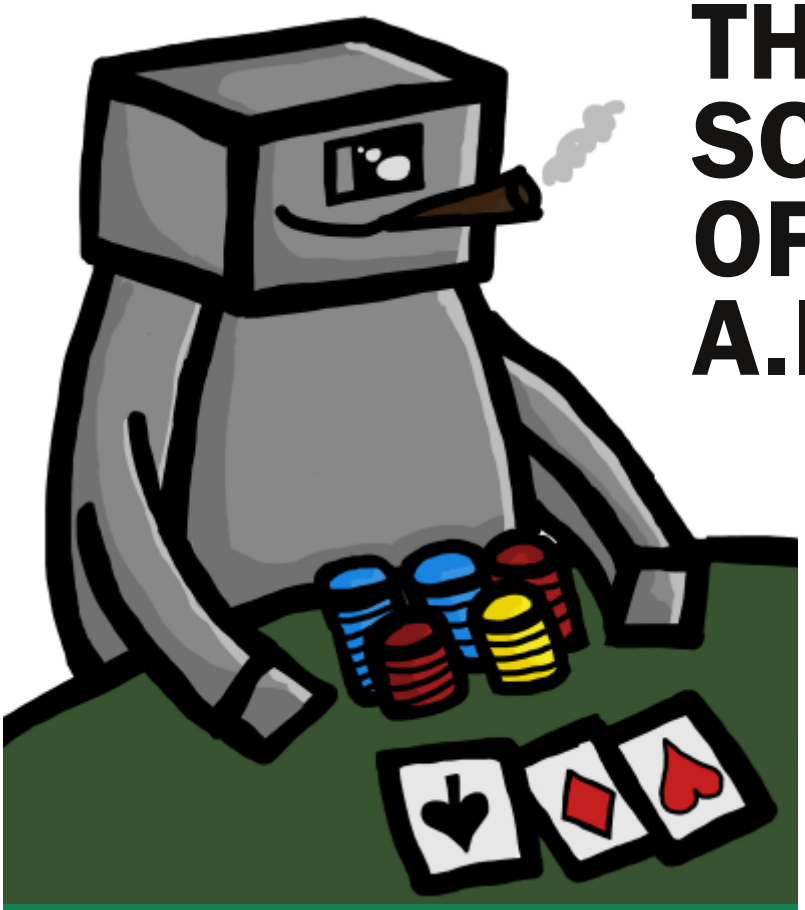
Further references can be found online at www.the-gist.org

Victoria Smith

// A VERY, VERY TINY SPIDER

There are several tiny spiders. One of the tiniest ones out there is the Patu Digua (not pictured) from Borneo. Apparently, this little guy when fully grown only measures up to around 0.37 mm in full body length.

THE SCIENCE OF GAME A.I.



Ailsa McCaffery

Luke Dicken discusses the work being undertaken by the Strathclyde Artificial Intelligence and Games research group to enhance our understanding of AI through games, as well as enhance our games through A.I.

For as long as there have been games, there have always been people wanting to play with fewer than the rules have intended. Back in the 1770s the public's imagination was captured by the 'Mechanical Turk', a device which was allegedly an automated chess opponent. Despite the attention, it was unfortunately revealed to be a hoax and was actually operated by a small man sat with the Turk's cabinet but it highlights just how long there has been a desire to play against artificial opponents.

Within the University of Strathclyde's Department of Computer and Information Sciences, the Strathclyde Artificial Intelligence and Games (SAIG) research group is taking a much more scientifically rigorous (not to mention more ethical) approach to the problem. Broadly speaking, there are two separate teams at work, with different emphases and justifications for their research.

The team that might most closely identify with the Mechanical Turk works in an area dubbed 'Chips as Champions'. These researchers are dedicated to using games to advance the state of the art of Artificial Intelligence (AI), helping to create machines better capable of reasoning and consequently more likely to win. This might seem a bit trivial – even with a computer capable of beating a chess grand master, our quality of life hasn't improved much, so why should people be interested? On the face of it, it's a fair point, but the important thing to factor in is that a lot of times, the games we are working with can also be seen as abstract representations of less trivial circumstances.

Poker is a very good example of this, as well as a game we focus a lot on at SAIG. Poker is a game of imperfect information, which is to say we don't know what cards the other players have. It is zero-sum, which means that for someone to gain money, the other players must lose the same amount of money. It's a game of probabilities but also posturing. These characteristics make it a very interesting challenge to try to solve using AI techniques. They also make any solution we can come up likely to be at least somewhat applicable to the stock market.

Pac-Man is another game of interest to this group – specifically the Ms. Pac-Man variant, in which the behaviour of the enemy ghosts is unpredictable. The focus of the research is on producing AI to play the game by controlling the Pac-Man and maximising its score. In Pac-Man, the character needs to navigate a maze, avoid the enemies and collect all the items within the maze to allow it to progress to the next one. This makes Pac-Man a really good abstract representation of some sort of security scenario, perhaps involving hostages that need to be collected, and different floors of an office building that need to be moved around whilst avoiding the bad guys. Even something as trivial and nonsense as finding better ways to play Pac-Man then might have broader implications and real-world applications, which makes the 'Chips as Champions' approach to games research particularly compelling.

On the other side of our group is a team that is a little bit more pragmatic. Video games are a huge (and growing) entertainment industry, and by their nature the products are one of the largest applications of AI going. Every game relies to some extent on AI to create the world that the player interacts with, the characters that populate

Bumm13 (Wikicommons, Pub. Dom.)

// Even the earliest video games, such as Pong required basic AI for one-player modes

that world and so on. This is true even for Pong (Atari, 1972), but is increasingly true as game developers aim for compelling and immersive recreations of environments. There's a need to enhance the AI techniques used within the industry to provide better experiences for players, and this is the focus of the second team. We work with industry experts around the world to establish where there is scope for improvement and to find solutions that reflect the realities of development in the games industry. This is an important aspect because AI is a very intensive field in terms of the computing power required. Some of the state of the art approaches we have in academia right now involve a powerful computer working solely on one problem for up to half an hour. In games, that same computer is also working on generating a rich graphical environment for the player to look at, processing the input from the player, perhaps handling a physical simulation of the objects in the world and how they are interacting. And of course it's typically happening in real-time, so the AI problems will have to be very quick – rather than taking a half hour, the solutions need to be generated in a handful of milliseconds.

Just making AI systems run that fast would be hard enough, but at the same time we need to alter what we are trying to achieve with that AI. The 'Chips as Champions' team is focused exclusively on winning the game, and achieving the highest score where applicable, but when we talk about video games, that's not an appropriate metric. The point of the game isn't to beat the player -- – if it were, then it would be a pretty easy task, we'd just make the game give the AI players an advantage in the game. That might be more resources in a strategy game, more health in a shooting game or even cars that can move a bit faster in a racing game. Putting that kind of bias into the game would make it harder, and make the AI system more likely to win.

It's relatively easy to see though that this wouldn't make for a better game experience. There's something else at work, and just making an unbeatable AI system isn't going to achieve what the industry wants. At SAIG, we instead think in terms of trying to 'optimise the fun'. This lets us look at how our techniques are going to affect the whole game, and what they are adding to the player's experience of the game.

At SAIG one of our big projects in this vein is working to try to create more believable characters in game worlds. Typically, the characters that the player interacts with are relatively simple in their logic. They need to be due to the processing constraints already mentioned. In turn however, that makes them relatively naive, and a lot of the richness that typical games exhibit is actually layers of smoke and mirrors, carefully designed to give an illusion of intelligence. This can lead to a very wooden-feeling world however, where characters will only react to a certain set of actions that the player takes, because these are the combinations of actions that the developers predicted. A great example of this is The Elder Scrolls V: Skyrim (Bethesda Softworks, 2011), which allowed players to pick items up and move them around with a relatively realistic physics simulation. At the same time, the player could take items lying around in people's homes and if the person saw you do it, they would react to the theft. Ingenious players around the world discovered that by combining these two elements, they were able to place items like buckets on AI characters heads, which meant that they couldn't see anything. As the developers hadn't predicted this possibility, the characters would sit passively, leaving the players free to pilfer to their heart's content. This highlights why we need better AI in our games – the game developers can't predict these emergent interactions, yet the characters need to be able to react both quickly and intelligently when things happen.

Artificial Intelligence is a very exciting field, and at SAIG we're able to combine our passion for games with this, allowing us to undertake some unique research that will hopefully be of value not just in terms of the games we play, but also more applicable to society as a whole.

// Luke Dicken is a PhD student at the University of Strathclyde in the UK, as well as the founder of Robot Overlord Games.

Ailsa McCaffery

// Complex AI rules can lead to loopholes that can be explioted by gamers, such as the "bucket on the head technique" discovered by Skyrim players

THE PUBERTAL DIP

Emilie Steinmark looks into the development of emotion recognition from body language in children and adolescents.

Emotion recognition

As humans we tend to establish groups amongst ourselves; a sense of belonging is completely essential for our wellbeing and our self-image. How well we work in social contexts is largely dependent on our ability to interpret the signals and behaviours of the people around us. The ability to read and interpret visual signals (visual stimuli) is not a given constant, but develops through childhood and adolescence. Psychological research has revealed a crucial change in this development around puberty.

Generally, we are experts on interaction. Most people, whether they are a 'people person' or not, clearly and without any conscious effort understand that if their little sister starts crying, something is wrong and she needs to be comforted. Similarly, we become very good at interpreting everything about the people around us: an irritated, aggressive shrug, an excited giggle, or a quick, hurt look. Had we not been experts on social interaction the concept 'an excited giggle' or 'an irritated shrug' would never have made sense – because, in reality, a giggle is a giggle, it can't be excited or otherwise. However, this does make sense because this is exactly how we use giggles, shrugs and looks: as information providers. They inform us about the emotional state of the person we're interacting with. The ability to read and interpret these signals is called emotion recognition.

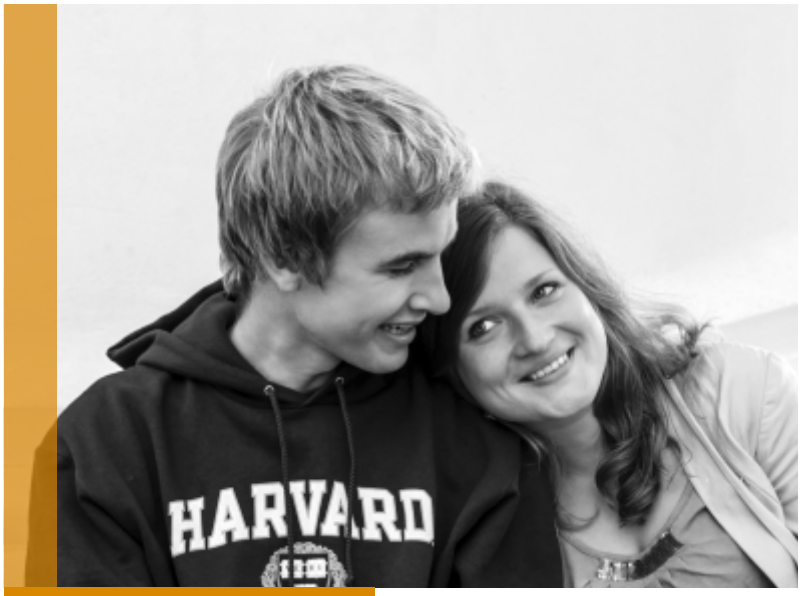
Emotion recognition is very much central to our social understanding, and psychologists have been interested in this area for years. During this time, a clearer picture of the development of this ability has begun to take shape. Naturally, a critical point in our social lives is when we start to orient ourselves not only towards our parents and closest family but increasingly towards our peer group: the early teenage years. This period, for many reasons, is a sensitive one – also with regards to emotion recognition.

The pubertal dip

In contrast to earlier findings, recent research from Duke University (2007)[1] found that emotion recognition continues to develop in adolescence. The study focused specifically on the emotions of fear and anger – two of the most important and fundamental emotions of human interaction. The researchers used images of different facial emotions and morphed these together in varying proportions of neutral and anger, neutral and fear, and fear and anger. Results showed that when adults and young people were asked to indicate which emotion was being shown adults were more sensitive to the subtle changes in facial expression. Hence, it was concluded that emotion recognition for facial expressions of fear and anger do not reach adult-like levels until after adolescence.

Not only does development continue into adolescence, an change in the rate of development has been identified around the onset of puberty. In 2002, researchers from San Diego University[2] found that there was a "pubertal dip" for processing emotionally related stimuli around the age of 11–12. The reaction time for correctly answering whether a presented mood word

Sanja Gjenero



Nijole Ukelyte

// How do we read situations like this?

matched the presented picture was significantly longer than in younger children, catching up again at around age 15 before subsequent improvement. Clearly the young teenagers seem challenged.

These two studies focused on emotion recognition of facial expressions. Although it is true that we obtain a lot of our information about emotional state from people's faces, it is far from the only way that we can obtain it. Recent research from the University of Glasgow[3] examined the development of emotion recognition from another form of visual stimuli: body language, a so far unexamined area within this field. The researchers found that although children in general performed poorer than adults in recognising basic emotions from body language, there was a clear difference in improvement over the years. From age 4 till age 8.5 the researchers found a steep improvement rate in performance. However, from late childhood into adolescence, the rate of improvement proved to be much slower.

Overall, the studies show a steady, steep improvement rate during childhood, then a period of little or no improvement starting at puberty and continuing until the late teenage years, followed by subsequent steep improvement rate until adulthood. The reasons behind these changes in rate have been linked to several factors, a prominent one being the late maturation of 'The Social Brain'[4] a collective term for brain areas involved in social interaction – including the prefrontal cortices (PFC)[5], associated with recognition of angry expressions (more specifically the orbitofrontal cortex OFC)[6], and the amygdala, associated with fearful facial expressions[7]. The Duke University researchers mention that their results indicate a slightly later maturation in recognition of anger compared to that of fear. This is unsurprising as it has previously been found that the PFC is one of the latest brain areas to mature[8].

Another reason often brought up in connection with puberty and the early teenage years is that of hormones. As part of the team behind the body language research at the University of Glasgow, PhD student Patrick Ross argues that although hormones may have some role in this development, it's unlikely to be the sole reason: "It has to be a combination of two, and possibly more, variables. As an extreme example, a child that has only been exposed to a few faces in their life will have a stunted development of the ability to recognise emotion from faces. The delay of improvement in this example would be purely down to social environment, so hormonal reasons can't be the only reason for a change in ability."

The role of the social environment

This leads to another aspect important in social recognition: the social environment. Hugely important in a number of developmental processes, such as attachment in the early stages of life, our social environment has a lot to say. It has been suggested that as our social environment changes in the beginning of adolescence, young teenagers must adopt new cognitive strategies to continue their improvement in emotion recognition. A cognitive strategy is a specific strategy for mental processes in a particular task. At this point in time, new research is focusing on the functional underpinnings of this possible shift in cognitive strategy. This means investigating how recognition of different visual stimuli measurably differs over time in terms of for example brain area size: "There are specific areas of the brain which respond to human bodies and faces. What we and other groups are starting to show with fMRI (functional Magnetic Resonance Imaging) is that the areas involved in emotional body perception may be adult like by late childhood, but the areas dealing with faces are actually getting bigger and more selective right into mid adolescence", Ross says.

On a social scale, several important things happen around puberty, most noticeably a change of focus toward one's peers as opposed to one's parents. An additional factor which may seem surprisingly simple also appears to be playing a large role: our height. Focusing on what is right in front of us we simply grow up to focus on faces. Ross explains: "As children, our main point of reference to determine an adult's emotional state is their body. However, as we get older, the face becomes the main point of reference in our peers. Coupling this simplistic solution with the fact that as we get older we will be exposed to many more faces, the increase in size and selectivity of the face areas of the brain really come as no great surprise."

Ross also identifies one of the research goals as plotting of the developmental trajectory for emotion recognition – not only for facial expressions, but for voice and body language as well: "If we can chart the developmental trajectory for typically developing subjects,

can we then shift this same paradigm and apply it to atypical developing subjects?" In order to accurately chart the trajectory of emotion recognition development, further research is needed and investigations have already been started. This will certainly lead us to a better understanding of emotion recognition in normally developing children and teenagers – and hopefully also to better insight into atypical development. Several disorders which may have impairments in emotion recognition, such as autism, schizophrenia and anorexia nervosa, have already made their way to the labs. And that's just for starters.

// Emilie Steinmark is a first year Psychology and Chemistry undergraduate at the University of Glasgow.

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// MINIATURE ENZYME 'SHUTTLES'

Joy Leckie investigates the tracking of fluorescent enzyme-quantum dot 'nano-shuttles' propelled by fibre formation, using 'bio-inspired motion at the nanoscale.

Directed motion at the nanoscale occurs within living cells by specific biomolecules called motor proteins. These proteins have the ability to overcome random Brownian fluctuations and move in a controlled fashion through the cell's cytoplasm. In some cases, the proteins can deliver essential cargo to target areas in the cell.

The author is investigating a simplified bio-hybrid 'motor', inspired by the directed motion occurring within cells. An enzyme's movement can be tracked by fluorescence microscopy by attaching it to a fluorescent nanoparticle. The enzyme-particle 'shuttle' is driven by self-assembly of a fuel molecule into fibre structures. This can be thought of as a rocket being propelled by the expulsion of gas, where the fibres represent the gas and the particle as the rocket.

This study can provide an understanding of enzyme movement during catalytic reactions, as well as a step towards transportation of cargo for nanoscale construction.

One of the main challenges in working with such small materials is that at this size range, the effect of gravity on the particles is negligible so the particles remain in suspension. The surrounding fluid molecules bump into the particles, displacing them leading to random Brownian motion. Another problem is that it's impossible to see nanoscale particles without powerful magnification.

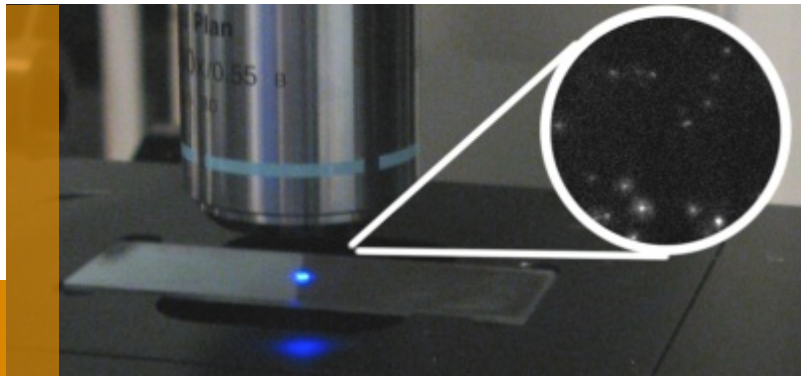
Therefore, attaching the enzyme to a fluorescence nanoparticle such as a quantum dot (QD) allows visualisation of the enzyme by fluorescent microscopy (see figure below). The resulting nanosized enzyme-QD will exhibit Brownian motion in water and upon addition of the fuel will show directed motion. The enzyme-QD is expected to be propelled and directed by self-assembly of the fuel molecules into fibre structures.

The fuel in this study is a simple biomolecule derivative called Fmoc-phenylalanine-tyrosine(phosphate). Self-assembly of the fuel molecule is initiated when the enzyme, alkaline phosphatase, chops off a section of the fuel molecule. The resulting molecules interact with each other, aligning and extending into fibre structures that in turn propel the enzyme.

"In recent years the investigation of miniature motors has become an increasingly popular area of research. So far, similar polymerization powered motors have been either purely artificial or take advantage of biological polymerization of the protein actin. This study incorporates enzymatic conversion of chemical energy to mechanical energy for motion of nanoparticles." says Rein Ulijn, Professor of Chemistry and Vice Dean Research (Science) at the University of Strathclyde and leader of the research.

Biohybrid 'motors', containing biological catalysts, could provide a route to the directed motion, transportation, construction and separation of materials at the nanoscale.

// Joy Leckie is a PhD student in Chemical and Process Engineering & Pure and Applied Chemistry at the University of Strathclyde.



// Fluorescent microscopy of enzyme-quantum dot conjugates

Joy Leckie

WHAT IS WRONG WITH MEDICAL SCIENCE REPORTING?

It's tricky to get science reporting correct. Why do we still see so many misleading headlines?

Health is an oft-broached matter in the mainstream press, but it is not always broached correctly. Medical science reporting often misses the point, which is a source of both endless amusement and frustration; witness the Daily Mail declaring items either causing cancer or curing it[1]. But why does reporting of clinical research fall short of the high standards to which it should be held?

It's easy to point the finger at those in charge running the media, to say owners and editors are more interested in increasing circulation figures than reporting accurately. It would be quite straightforward to apply a little editorial creative misinterpretation to make a story where there is none, or to ascribe importance to a finding above what would be warranted. It would be naïve to claim that the press has no standards – the Leveson Inquiry will suffice in that regard – so there must be more to the issue than sexing up headlines to boost sales.

So if it is not those printing the papers, how about the people doing the writing? There are many possibilities as to why science reporting may fall short of the mark. Ideally journalists reporting would be well-versed on the particular subject, but this isn't possible given the diversity of research being conducted. Ideally, the journalists would have adequate time to investigate the background of the topic. But deadlines and churn in mainstream reporting means that at best there may only be scope for an occasional feature around a 'health issue' – rarely, if ever, is time devoted to the implications of one piece of research.

These pitfalls are well-known, so surely scientists can make their work as accessible as possible? Well, to pick an example from the latest (at time of writing) edition of the New England Journal of Medicine, I'm not so sure: 'Combined BRAF and MEK Inhibition in Melanoma with BRAF V600 Mutations'[2]. That title isn't accessible to mainstream journalists, at least not to those without a degree in biology. Perhaps this isn't a huge problem – after all, the article is behind a paywall, so a hypothetical journalist wouldn't be able to read the article to find out what the title meant. If they did have access, the specialist terminology within has an even greater chance of confusing a layperson than the title. The way in which research is presented falls well short of the mark in accessibility.

Bemoaning journals for lack of accessibility is tilting at windmills in some respects. After all, they are a forum for scientists to report their findings to other scientists; not a venue for explaining implications to the general public.

Scientists aren't supposed to simplify; that is for journalists to do. So journalists often get their information from press releases, and here is the crux of the problem: press releases often over-sell research.

The problem of overstated press releases is widespread, but one example will suffice. The Jupiter trial[3] made headlines in 2008 and has been back in the press again as of a couple months ago. That study

// How do we make sure medical reports are accurate?

Michaellaumy (Wikicommons, CC-SA-1.0)

compared giving rosuvastatin (a cholesterol-lowering drug in the class known as statins) to people with normal cholesterol but raised CRP (C-reactive protein, an indicator of inflammation) to giving a placebo, and examined whether this had any effect on heart disease. Back when the original article appeared in the New England Journal of Medicine, there were reports in the press that the 'astonishing' results showed that the "risk of a heart attack was reduced by 54%". A flurry of discussion and debate followed, centring around the suggestion of giving statins to healthy individuals with low risk of heart disease. There was even a slightly-facetious suggestion to put statins in drinking water.

The points that were missed were that the "54% reduction in heart attacks" result referred to a relative reduction (that is, a comparison of the ratio between the groups being studied of heart attacks), instead of an absolute reduction. Expressed in absolute terms, the probabilities of each group having a heart attack was 0.35% for those that took rosuvastatin and 0.76% for those who took a placebo. The trial was also stopped early, although this lent weight to the suggestion to give everyone statins, rather than raising cautions about the long-term conclusions of the study. There was also a higher rate of diabetes diagnosed in the group that was given rosuvastatin, which should also indicate caution. Unfortunately, here and in similar cases the headline figure is remembered and the problems are forgotten or dismissed – if they were even discussed in the first place.

Where did the emphasis on these figures come from? The journalists didn't cherry-pick data from the tables in the paper; it came from the press release announcing the results. It is hard to castigate supposedly lazy journalists or greedy newspaper owners when their source is misleading. Here again, it is easy to see why the press releases may be written this

A basic checklist for reading articles or headlines about health research

Is it a front-page or other very prominent article?

→ Treat with caution. Headlines are designed to grab attention; front-page articles are (more or less) there to convince you to buy a newspaper or magazine.

Is the research being called a 'wonder drug', 'silver bullet' or 'wake-up call'?

→ We will eventually (hopefully!) find cures and excellent treatments, but most of the time what we find are slightly better ways of treating diseases than we already do.

Are percentages large?

→ Often relative risk reductions are reported as these are bigger, as bigger numbers have a greater impact. It is worth finding out what the absolute risk is as this may be surprisingly low.

Is the type of research mentioned?

→ 'Double-blinded randomised controlled trials' have been called the "gold standard" of clinical research, but these aren't always possible. Some basics should be borne in mind, however – the Lancet once questioned whether sage was a superfood... based on a study conducted on a small group of rats!

e-magic (Flickr, CC 2.0)

// Magic pills or real medicine?

way: universities want to trumpet their achievements in the hope of raising or maintaining their profile, or if it was a drug company that conducted research, stating the importance could result in their financial gain. The writing of press releases may occur totally or mostly independent of the team that did the research, instead handled by 'corporate communications'. If the institution has a PR company to 'manage their image', writing the press release may even happen through them. This is not a good way to avoid being misleading.

How can this problem be fixed? One way would be for newspapers to employ very specialised journalists and give them free reign to investigate a topic without constraints of time or resource. While we're wishing, I'd like a pony. Perhaps a more realistic solution would be to instigate a standardised reporting format for press releases. There are already standardised formats for reporting results in literature (for example see the CONSORT initiatives for reporting randomised controlled trials[4]) which have gained acceptance. A standard format for press releases that established good practices would help improve the standard of reporting in the media, and there is an effort underway to bring this about.

But in the meantime, what can be done given the paucity of good medical science reporting? Who and what should we believe? There are those out there who are interested in seeing accuracy over sensation. Margaret McCartney, a Glasgow GP who writes about evidence-based medicine, is trying to establish a standard for writing press releases and was the main inspiration for the article. The blogs Bad Science (Ben Goldacre) and DC Science (David Colquhoun) are also good places to start. 'Behind the Headlines' from NHS Choices can be helpful too. When taking other people's views on clinical research into account, perhaps the most important page to read is the person's 'About' page. It's worth knowing what a person's biases or conflicts of interest are and the more up-front they are about who they are and why they write, the clearer it is to interpret what they say.

Research in any field generates controversy and disagreement. Medical science is no different. But when the reporting has the potential to impact on the fears and anxieties of the public, a degree of caution and forethought are merited. Poor reporting has the potential to undermine trust in science – many have heard the argument 'Well, science doesn't really know what's best for us' used as a dismissal of good, practical advice. I do sympathise with that view as it's true, no-one yet knows what's best. Research is an incremental process, slowly expanding the boundaries of understanding into the unknown. To herald each small step as a breakthrough, wonder drug or silver bullet is to overlook the importance of what we already know, and each apparent contradiction compounds the weariness and cynicism directed at medical science.

// Rob Hallam is a medical student at the University of Glasgow.

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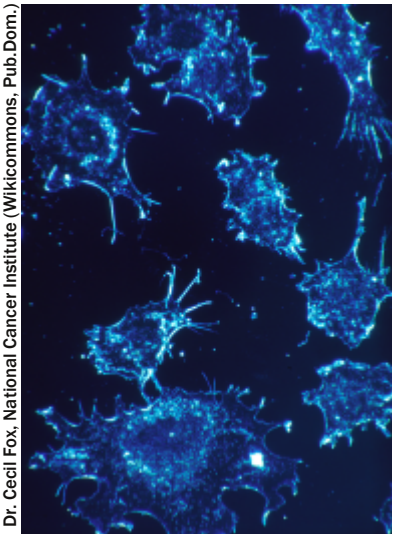
// CANCER OF THE UNKNOWN PRIMARY

Cancer of unknown primary (CUP) is a diagnosis of metastatic disease without detection of a primary tumour site despite a complete routine diagnostic work-up. CUP accounts for 3–5% of all cancer diagnoses, putting it in the top ten cancers worldwide. It is also a leading cause of cancer mortality being the 4th highest cause of cancer death with the best median survival quoted as 6–12 months. Very little is known about this medical entity however and in the majority of cases, investigation and treatment of the disease is suboptimal.

Even after more advanced investigations to discover the primary site in CUP such as combined PET/CT imaging and immunohistochemical staining of the tumour cells to detect any known cellular markers, a primary tumour site is currently found in only 25% of CUP patients before death. Even after autopsy, 15–25% remain undiagnosed. There are two hypotheses as to why the primary is so difficult to detect in genuine CUP. The first states that CUP is in fact a primary metastatic disease which therefore has no site of origin. The second hypothesis is that a primary tumour either never grew to a detectable size or it regressed at some stage in the progression of the cancer. As site specific treatments advance and become available in a wider range of cancers however, finding the primary site in CUP if it exists is more crucial than ever.

Whether the focus of CUP diagnosis remains finding the site of origin or shifts to treating CUP as its own medical entity, it is generally accepted that the treatment of CUP (like that of all other cancers) will become increasingly targeted. Whether this will come from a better understanding of CUP itself or from better diagnoses of a primary site in these patients remains to be seen.



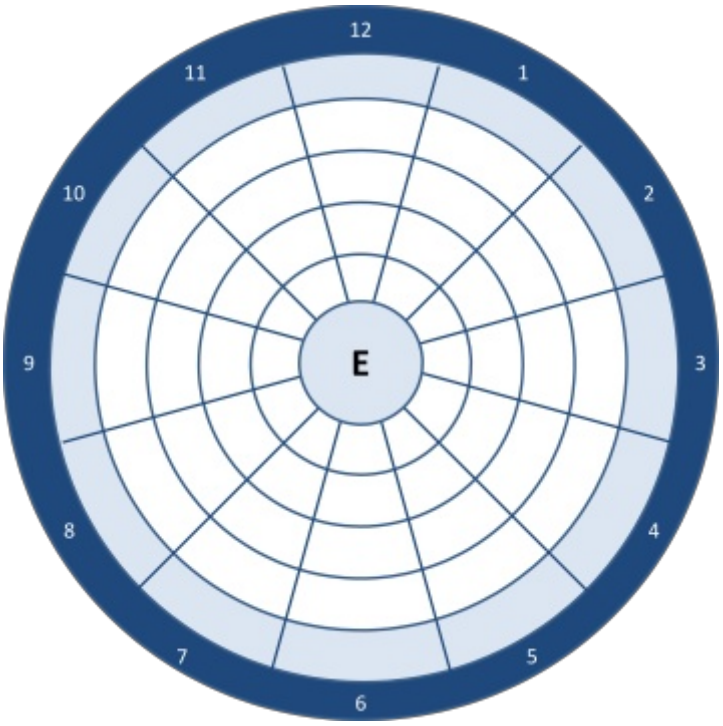
Dr. Cecil Fox, National Cancer Institute (Wikicommons, Pub.Dom.)

// Jenny Ferguson is a student at the University of Strathclyde.

THE BACK PAGE

SCI-CIRCLE

by David Iain Houston



1. the intrinsic property of matter responsible for all electric phenomena

2. an organism that requires oxygen to grow

3. radar and infrared photography are forms of ____ sensing

4. peas and beans are examples of this plant family

5. a bone in the wrist adjacent to the scaphoid, also meaning crescent or moon-shaped

6. a halogen, its name comes from the Greek for purple

7. types of species at risk to foreign invaders

8. common name for the flowering plants of the genus Utrica, makes a mean soup but be careful when preparing

9. a class of monosaccharide sugars containing an aldehyde group

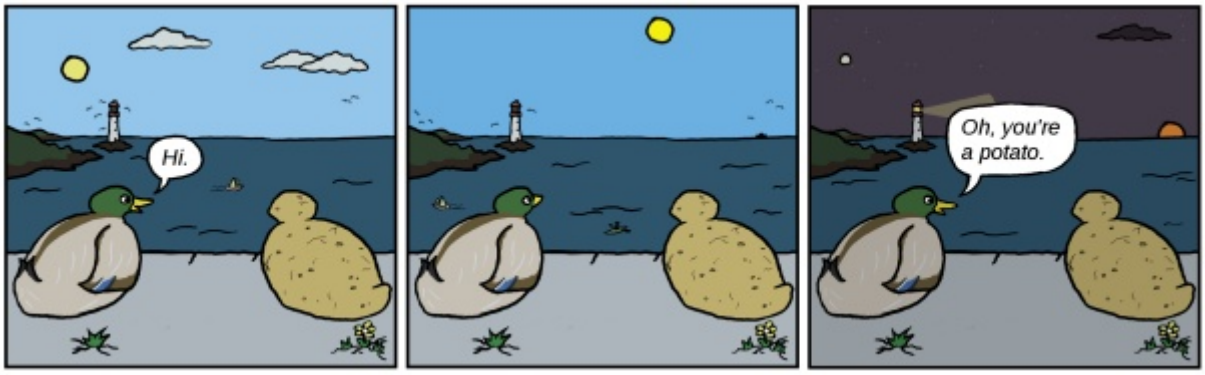
10. machine designed to convert energy into useful mechanical motion / discovered by Faraday this chemical compound has two carbons and is an odourless and colourless gas

11. in astronomy the completely dark portion of the shadow cast by the earth, moon, or other body during an eclipse (pl.)

12. the volume of what is defined as: V = 4/3πr3

FIGURE 1

by Johnny Stormonth-Darling



Occasionally potatoes have been known to show an outstanding morphological similarity to the common duck. Is this an intriguing insight into a hitherto unexplored subfield of genetics, or merely a visually humorous coincidence?

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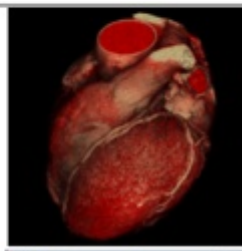

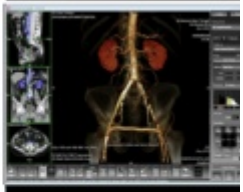

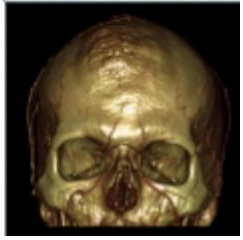

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