

Computer programming

And now for something completely different

Python, a simple and versatile computing language, has brought coding to a vast new audience

IN DECEMBER 1989 Guido van Rossum, a Dutch computer scientist, set himself a Christmas project. Irked by shortcomings in other programming languages, he wanted to build his own. His principles were simple. First, it should be easy to read. Rather than sprawling over line-endings and being broken up by a tangle of curly braces, each chunk would be surrounded with indented white space. Second, it should let users create their own packages of special-purpose coding modules, which could then be made available to others to form the basis of new programs. Third, he wanted a “short, unique and slightly mysterious” name. He therefore called it after Monty Python, a British comedy group. The package repository became known as the Cheese Shop.

Nearly 30 years after his Christmas invention, Mr Van Rossum resembles a technological version of the Monty Python character who accidentally became the Messiah in the film “Life of Brian”. “I certainly didn’t set out to create a language that was intended for mass consumption,” he explains. But in the past 12 months Google users in America have searched for Python more often than for Kim Kardashian, a reality-TV star. The rate of queries has trebled since 2010, while inquiries after other programming languages have been flat or declining (see chart on next page).

The language’s popularity has grown

not merely among professional developers—nearly 40% of whom use it, with a further 25% wishing to do so, according to Stack Overflow, a programming forum—but also with ordinary folk. Codecademy, a website that has taught 45m novices how to use various languages, says that by far the biggest increase in demand is from those wishing to learn Python. It is thus bringing coding to the fingertips of those once baffled by the subject. Pythonistas, as aficionados are known, have helped by adding more than 145,000 packages to the Cheese Shop, covering everything from astronomy to game development.

Mr Van Rossum, though delighted by this enthusiasm for his software, has come to find the rigours of supervising it, in his role as “benevolent dictator for life”, unbearable. He fears he has become something of an idol. “I’m uncomfortable with that fame,” he says, sounding uncannily like Brian trying to drive away the crowds of disciples. “Sometimes I feel like everything I say or do is seen as a very powerful force.” On July 12th he resigned, leaving the Pythonistas to manage themselves.

Nobody expects the faddish statistician Python is not perfect. Other languages have more processing efficiency and specialised capabilities. C and C++ are “lower-level” options which give the user more control over what is happening within a

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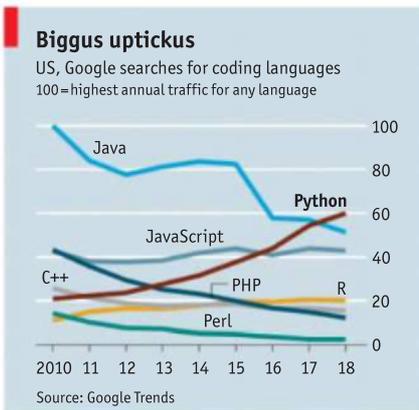
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computer’s processor. Java is popular for building large, complex applications. JavaScript is the language of choice for applications accessed via a web browser. Countless others have evolved for various purposes. But Python’s killer features—simple syntax that makes its code easy to learn and share, and its huge array of third-party packages—make it a good general-purpose language. Its versatility is shown by its range of users and uses. The Central Intelligence Agency has employed it for hacking, Pixar for producing films, Google for crawling web pages and Spotify for recommending songs.

Some of the most alluring packages that Pythonistas can find in the Cheese Shop harness artificial intelligence (AI). Users can create neural networks, which mimic the connections in a brain, to pick out patterns in large quantities of data. Mr Van Rossum says that Python has become the language of choice for AI researchers, who have produced numerous packages for it.

Not all Pythonistas are so ambitious, though. Zach Sims, Codecademy’s boss, believes many visitors to his website are attempting to acquire skills that could help them in what are conventionally seen as “non-technical” jobs. Marketers, for instance, can use the language to build statistical models that measure the effectiveness of campaigns. College lecturers can check whether they are distributing grades properly. (Even journalists on *The Economist*, scraping the web for data, generally use programs written in Python to do so.)

For professions that have long relied on trawling through spreadsheets, Python is especially valuable. Citigroup, an American bank, has introduced a crash course in Python for its trainee analysts. A jobs website, eFinancialCareers, reports a near-four-fold increase in listings mentioning Python ▶▶



▶ between the first quarters of 2015 and 2018.

The thirst for these skills is not without risk. Cesar Brea, a partner at Bain & Company, a consultancy, warns that the scariest thing in his trade is “someone who has learned a tool but doesn’t know what is going on under the hood”. Without proper oversight, a novice playing with AI libraries could reach dodgy conclusions. Bernd Ziegler, a partner at Boston Consulting Group, says that his firm reserves such analysis to members of its data team.

Rossum’s universal robot

One solution to the problem of semi-educated tinkerers is to educate them properly in the language’s arcana. Python was already the most popular introductory lan-

guage at American universities in 2014, but the teaching of it is generally limited to those studying science, technology, engineering and mathematics. A more radical proposal is to catch ‘em young by offering computer science to all, and in primary schools. Hadi Partovi, the boss of Code.org, a charity, notes that 40% of American schools now offer such lessons, up from 10% in 2013. Around two-thirds of 10- to 12-year-olds have an account on Code.org’s website. Perhaps unnerved by a future filled with automated jobs, 90% of American parents want their children to study computer science.

How much longer Python’s rise will continue is anybody’s guess. There have been dominant computer languages in the past that, while not exactly “one with Ninveh and Tyre”, now skulk in the background. In the 1960s, Fortran bestrode the world. As teaching languages for neophytes, both Basic and Pascal had their moments in the sun. And Mr Partovi himself plumped for JavaScript as the language for Code.org’s core syllabus, since it remains the standard choice for animating web pages.

No computing language can ever be truly general purpose. Specialisation will necessarily remain important. It is nevertheless true that, in that long-past Yuletide, Mr Van Rossum started something memorable. He isn’t the Messiah, but he was a very clever boy. ■

as several thousand DNA base pairs. This raises the possibility that non-target genes or regulatory sequences could be affected by the editing process, a discovery which comes in the wake of other recent work which raised concerns that CRISPR-Cas9 gene-editing might trigger cancers. Cue investor panic and nosedives in the share prices of gene-editing companies.

Although Dr Bradley’s study certainly adds to concerns over the accuracy and safety of CRISPR-Cas9, it is by no means a show stopper. There are a number of caveats which may, in time, turn out to mean the findings are less concerning than they seem today.

For one thing, as Robin Lovell-Badge, an expert in the area who works at the Francis Crick Institute in London, observes, the study focuses on a form of genome-editing called “non-homology end joining”. This, he says, is known to be an untrustworthy approach compared with other ways of using CRISPR-Cas9. Moreover, the actual impact of the technique (and, indeed, of any gene-editing tool) will depend on the types of cells being edited and the nature of the changes being made.

Dr Lovell-Badge says that “it is not clear that the specific protocols used in the paper would relate much to any sensible use of genome-editing clinically”. In any case, CRISPR editing is a work in progress. New versions of the technique are being developed, with the intention of improving its accuracy and efficiency. Problems with one particular approach will doubtless act as a spur to innovation in others.

Dr Bradley’s study does nevertheless serve as a timely reminder of the need for caution when the technology is used in people. (It raises fewer concerns for gene-editing in research and for agricultural purposes such as crop improvements, where off-target effects are of less consequence.) Clinical applications will need to show that the only alterations are those that were intended.

In particular, the study raises the stakes for those who wish to make heritable changes to the human genome. This week a group of bioethicists concluded, in a report for the Nuffield Council on Bioethics, a think-tank in Britain, that in some circumstances the genetic engineering of human sperm, eggs or embryos could be morally acceptable. The technology is seen as potentially useful for removing heritable diseases or for reducing genetic predispositions to cancer.

But the report concluded that two principles should serve as a guide. One is that the changes brought about by gene-editing should not increase “disadvantage, discrimination or division in society”. The other is that such changes should be consistent with the welfare of the future person. For that to happen, any form of gene-editing needs to be demonstrably safe. ■

Medicine

Cutting to the truth

The safety of CRISPR-Cas9 gene editing is being debated

A GREAT deal rides on the accuracy of the gene-editing tool known as CRISPR-Cas9. Since its discovery in 2012 it has become popular for tinkering with genomes of all kinds, thanks to its ability to make editing cheap and easy. Firms such as CRISPR Therapeutics, Intellia Therapeutics and Editas Medicine have been built on the idea that it could be used to develop treatments for human diseases. Editas, based in Cambridge, Massachusetts, announced this year that it would work on five new human medicines over the next five years.

In China the technology is already in clinical use. In Hangzhou Cancer Hospital, for example, CRISPR-Cas9 is being employed to engineer immune-system cells removed from patients with cancer of the oesophagus. The hope is that when the engineered cells are returned to a patient’s body, the editing will have improved their ability to attack tumours. More studies in-

volving human beings are expected in other countries for the treatment of beta-thalassaemia, a blood disorder, and Leber’s congenital amaurosis, a form of blindness. Further ahead, there is hope that CRISPR-Cas9 will help treat diseases such as AIDS, cystic fibrosis, Huntington’s chorea and Duchenne muscular dystrophy.

However, a study just published in *Nature Biotechnology* has found that when CRISPR-Cas9 is used to edit genomes, off-target DNA damage is more common than had previously been appreciated. This piece of research, co-ordinated by Allan Bradley of the Wellcome Sanger Institute, in Cambridge, England, looked at genetic changes in mouse and human cells across large stretches of the genome. In around 20% of cells examined, the use of CRISPR-Cas9 had caused unintended deletions or rearrangements of strings of DNA more than 100 base pairs long—and some as long

Archaeology

Toast before tillage

An excavation in the Middle East shows that bread predates farming

ABSENCE of evidence is not evidence of absence. The value of that aphorism has just been shown by a discovery made at Qa' Shubayqa, in north-eastern Jordan. Amaia Arranz-Otaegui of the University of Copenhagen and her colleagues found breadcrumbs in two ancient fireplaces there. Not that unusual as archaeological discoveries go, except that these fireplaces were between 14,200 and 14,400 years old. The loaves the crumbs came from were thus baked more than 4,000 years before the beginning of agriculture.

That bread was coeval with cereal farming was an easy idea to accept in the absence of contrary evidence—as was the case until the publication of Dr Arranz-Otaegui's discovery in the *Proceedings of the National Academy of Sciences*. Before it, the oldest evidence of breadmaking was from 9,100 years ago, in Anatolia.

Altogether, Dr Arranz-Otaegui and her colleagues found 24 charred breadcrumbs (one of which is pictured below) scattered in the ashes in the fireplaces. Each was several millimetres across. The hearths themselves had been laid by people now known as Natufians, who were hunter-gatherers. The crumbs were among more than 65,000 burnt fragments of plants such as tubers, legumes and wild grains. The bread's ingredients were species of wheat and barley growing wild in the region (which was at that time fertile, though it is now desert), and crushed tubers from *Bolboschoenus glaucus*, a type of papyrus.

Dr Arranz-Otaegui is not claiming that breadmaking was common this early in human history. Indeed, she acknowledges that even though her find shows that people knew how to bake the stuff 14,000



Crumbs!

years ago, foraging for the ingredients would have been a considerable chore. Which leads to the question, why bother?

One hypothesis which might answer that question, but for which there is still a complete absence of evidence, is that beer-making, too, is older than believed. The oldest evidence of brewing suggests that beer was originally made from bread rather than directly from grains. This has led some people to hypothesise that acting as a feedstock for brewing was bread's initial purpose. Only later did it become the staff of life.

If the Natufians did understand how to brew beer from bread, that would surely be a motive to search out the relevant ingredients and go to all the trouble of grinding them into flour, mixing them with water to form a dough, and then baking them. Indeed, it would be motive to start garnering some of those seeds and planting them in small patches of cleared ground, so that they could more easily be collected. The question “why bother”—both with baking and with tillage—might have its answer if further excavations at Qa' Shubayqa or elsewhere reveal evidence of the world's oldest brewery. ■

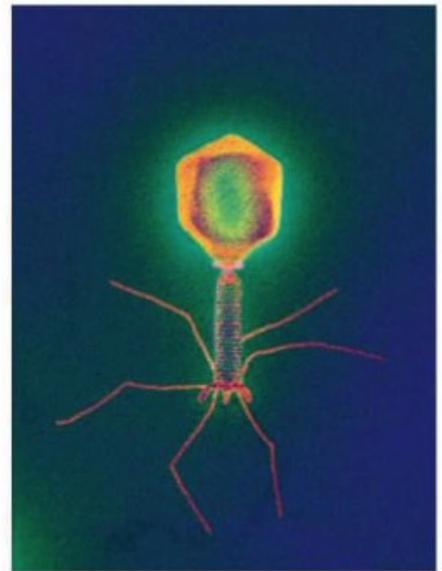
Virology

Second-mover advantage

Viruses that attack bacteria have evolved to collaborate

THAT predators often hunt in packs is a commonplace. Wolves do it. Killer whales do it. Even *Velociraptor*, a species of dinosaur made famous by “Jurassic Park”, is believed to have done it. These are, or were, all intelligent species, capable of exchanging and interpreting information. But the logic of pack hunting, that many may achieve what one alone cannot, and that individual pack members may perform different roles, does not depend on intelligence. Indeed, evidence has now emerged that this logic applies to viruses, the simplest biological entities of all. It was published this week in *Cell*, by Edze Westra and Stineke van Houte at the University of Exeter, in England.

The viruses in question are bacteriophages, which “hunt” bacteria. They do not eat their prey. Rather, they take over its genetic apparatus to create replicas of themselves, killing the host as a consequence. To do so they have to penetrate a bacterium's cell wall and then subvert its internal defences, of which there are several. One of the best known, because it is the basis of an emerging gene-editing technology (see previous page), is called CRISPR.



Leader of the pack

The CRISPR system detects and cuts up alien DNA. In the wild, such DNA will almost always have come from a virus. To counter this, some bacteriophages have evolved ways of gumming up CRISPR's cellular machinery. Dr Westra and Dr van Houte have shown that, in essence, such phages collaborate. Some do the gumming. Others hijack the genetic apparatus.

Dr Westra and Dr van Houte were able to deduce what was going on by watching oddities in the rise and fall of bacterial and phage numbers in cultures. On the face of things, a population of CRISPR-armed bacteria would be expected to plummet in the presence of phages counter-armed with anti-CRISPR mechanisms. But this does not always happen. Instead, bacteriologists studying the matter have noticed that phages with anti-CRISPR traits are sometimes unsuccessful in attacking bacteria with CRISPR defences, and die out. Perplexed by this, the two researchers decided to take a closer look.

To do so, they and their colleagues generated a population of CRISPR-armed bacteria and another of phages with anti-CRISPR traits, and monitored exactly what happened when they introduced the one to the other. To start with, the density of viruses always declined. In other words, most of the early anti-CRISPR attacks were unsuccessful. These failed attacks did not leave the bacteria unscathed though. They resulted in the CRISPR defensive systems being weakened, a process the researchers were able to track by stopping an attack in midstream, washing away the phages, and testing the ability of the remaining bacteria to chop up alien DNA.

After this initial fall in viral numbers, if the culture was left long enough—and if there were enough phages in the first place—things eventually turned round. As the number of bacteria with weakened de- ▶▶

► fences increased, more and more of them were subject to subsequent, lethal attacks, resulting in the creation of more phages. Ultimately, as the phages multiplied, the bacteria were overwhelmed and wiped out. Whether bacteria or viruses prevailed thus depended on the initial ratios of the two. Below a certain threshold of phage abundance at the beginning, the bacteria prevailed; above it, the viruses did.

Intriguingly, the evolutionary success of the phages' approach depends on a second phenomenon—also first studied in social animals—as well. This is kin selection. It relies on the fact that genetically determined behaviour that harms an individual can nevertheless spread if it disproportionately helps kin that carry the same genetic trait. In the case of the phages, the anti-CRISPR mechanism is exactly such a trait. Some viruses carrying it sacrifice themselves so that others may multiply.

Understanding this interaction between phages and bacteria is important, though, for reasons beyond its evolutionary elegance. One such is that phages are

under consideration as alternatives to chemical antibiotics, particularly in situations where bugs are immune to those antibiotics. A second is that phages are a crucial, though ill-understood, part of the gut microbiome, the importance of which to human life is becoming clearer by the day. A third is that the interactions of phages and their hosts may be analogous to those of other viruses and other hosts, including human beings. Though animals do not employ CRISPR as part of their defence against viruses, they have a host of other antiviral mechanisms.

Dr Westra and Dr van Houte argue that theories about the spread of disease do not sufficiently take into account the possibility of these defences being damaged and weakened by failed attacks when determining the threats posed by specific sorts of viral pathogen. Monitoring such damage, and the degree to which it makes organisms vulnerable to later attacks, might improve control of the transmission of such diseases, and also the treatment of those who catch them. ■

Like a small plane, an autogyro employs a propeller (either front-mounted, as Earhart's was, or at the rear, like 007's and the Liberty's) to provide forward thrust. But instead of having fixed wings, an autogyro's lift comes from a rotor. Unlike a helicopter's, though, this rotor is not powered by the engine. Instead, it is turned by oncoming air, a result of the propeller's forward thrust, flowing over the blades.

According to PAL-V the Liberty can take off and land on a runway as short as 90 metres. In aircraft mode, it can carry two people at up to 180kph (about 110mph) for a distance of 400-500km. Folding up its rotors, tail and propeller, which takes ten minutes, turns it into a car.

In either mode the Liberty consumes standard petrol, so is easy to refuel. And in the event of an engine failure while airborne, PAL-V claims, it could flutter down safely onto a patch of land no bigger than a tennis court. To be on the safe side, however, it is fitted with two small combustion engines, either of which could be used to fly or drive it if the other stops running.

Unlike the makers of some other novel small aircraft, PAL-V has eschewed electric power, at least for now. Existing batteries cannot provide a useful range, says George Tielen, the firm's test pilot. And unlike passenger-drone companies, whose products employ several electric rotors to take off and land vertically, PAL-V is not seeking approval for autonomous operations. Requiring people to have both a driver's and a pilot's licence lets the company meet existing rules and thus enter the market faster.

According to Mr Tielen, the Liberty will allow someone to drive to an airfield or other suitable strip of terrain, take off, fly to somewhere similar near his destination, land and complete his journey by road—with the flexibility that if, say, the weather were to turn nasty while he was there, he could then drive home. That convenience, though, comes with a price tag that starts at €300,000 (\$350,000). Which would buy a lot of air fares and Uber rides. ■

Flying cars

A James Bond special

FARNBOROUGH

A modern take on 007's autogyro

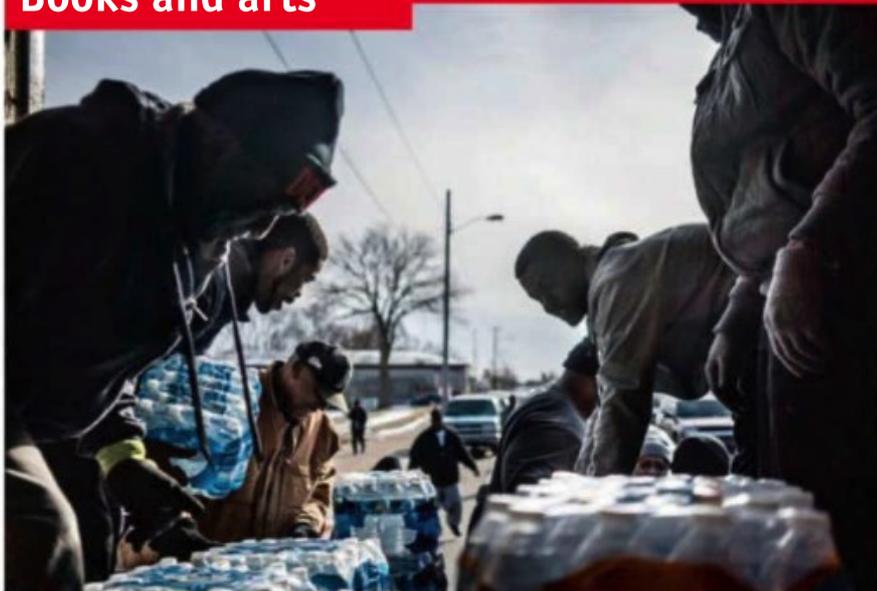
UNUSUAL aircraft are a regular sight at the Farnborough air show, which opened in Britain this week. But the particular unusualness of the Liberty is not so much that it is a flying car, but that flies as an autogyro. Although the Liberty remained firmly on the ground during the show, it is described by its makers, PAL-V, a Dutch firm, as a "production model" that will be used to obtain the necessary approvals for use on the road and in the air, so

that deliveries can begin in 2020.

Autogyros have been around since the early days of aviation. Amelia Earhart set an altitude record in one in 1931. Three years later, an autogyro carried a soon-to-be jilted groom to what he thought would be his wedding, in a film called "It Happened One Night". Another film, "You Only Live Twice", which was released in 1967, featured an autogyro called *Little Nellie*, piloted by James Bond.



OK Blofeld. I'm coming after you



The Flint water scandal River of fire

FLINT, MICHIGAN

Two books explore the causes and consequences of one of America's biggest public-health disasters

“YOU really do not want to miss this,” says J.D. Winegarden, a third-generation Flintonian, as he conducts a tour of the nicest bits of his city. From the sylvan grave of Jacob Smith, a fur-trader who founded the town in 1819, he whizzes past Factory One, the birthplace of General Motors, to the Flint Institute of Arts, with its surprisingly snazzy glass collection, and the adjacent planetarium. Beyond blocks of boarded-up houses, many of them still beautiful, Mr Winegarden shows off University Avenue, which connects two of Flint's five colleges. The tour ends in a posh neighbourhood near downtown, where in the 1920s GM executives built mansions that rival each other in elegance.

Flintonians are proud of their home town and resent its status as an emblem of urban decay. “It is so important to come and see,” implores Karen Weaver, the mayor, regretting the damage inflicted by the water scandal on Flint's already grim reputation. As well as ranking among America's poorest and most violent cities, Flint is now known as a place where the government poisons its citizens with brown, foul-smelling water—and then lies about it until the evidence is irrefutable.

How did one of America's most prosperous places sink so low? Like Detroit, 60 miles to the south, Flint was once a hub of industry. In its heyday GM employed 75,000 workers there; the main drag features statues of Louis Chevrolet and David Buick. As recently as 1980, the self-pro-

The Poisoned City: Flint's Water and the American Urban Tragedy. By Anna Clark. *Metropolitan Books; 320 pages; \$30*

What the Eyes Don't See: A Story of Crisis, Resistance and Hope in an American City. By Mona Hanna-Attisha. *One World; 384 pages; \$28*

claimed “Vehicle City” had the highest median income for American workers under 35. But Flint was over-reliant on one company and was hit hard by the downturn in carmaking. These days GM employs fewer than 7,000 in the city.

Unemployment led to white flight, followed by middle-class black flight, which in turn led to a shrinking tax base and a predominantly African-American population falling into poverty. Today Navy SEAL medics reputedly train in Flint because it offers the country's closest approximation to a metropolis blighted by years of war.

Nor any drop to drink

Seven years ago Rick Snyder, Michigan's Republican governor, declared Flint to be in a state of financial emergency. He appointed an emergency manager with broad powers to run the struggling city's affairs—and cut costs wherever possible. This is the backdrop to the public-health disaster chronicled in “The Poisoned City” by Anna Clark, and “What the Eyes Don't See” by Mona Hanna-Attisha. Ms Clark is a De-

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troit-based journalist; Ms Hanna-Attisha is a paediatrician who helped to expose the contamination of Flint's water supply.

Ed Kurtz, the original emergency manager, faced a tough job. How do you cut costs in a city where 40% of the population lives below the federal poverty line? He and his successor, Darnell Earley, reduced municipal services to a bare minimum. Notwithstanding the crime rate, the police department shrank; in a place with a propensity to arson, firefighters were laid off. A fateful decision was made in April 2014. To reduce the high water bills, the municipal water source would be switched from Lake Huron to the local Flint river. “Everyone from Flint knows the river is highly toxic,” says Mr Winegarden, because of the industrial sludge that poured into it. Local lore says the river has caught fire twice.

Had the dirty river water been treated with the right chemicals, thousands of people would not have been poisoned by lead and bacteria, including one that causes Legionnaires' disease. But to save more cash, the city declined to add anti-corrosion agents that would have stopped the water eating away at the lining of the pipes, thus preventing lead from leaching out. That might have cost around \$100 a day—peanuts compared with the hundreds of millions that the state and federal governments are now forking out to repair some of the damage.

These two books both show how an austerity drive with racial undertones led to the mass poisoning of mostly poor and black residents, and how officials tried to cover it up, attempting to discredit anyone who came up with proof that the water was tainted. But they are complementary. Ms Clark is more analytical. “Lead is one toxic legacy in American cities,” she writes. Others include segregation, redlining and the practice of well-heeled neighbourhoods splitting off to form their own ▶▶

► municipalities. “This is the art and craft of exclusion. We built it into the bones of our cities as surely as we laid lead pipes.”

Ms Hanna-Attisha is more personal and emotional. She vividly describes the effects of lead-poisoning on her young patients. Even at low levels, the damage is irreversible, she says. For an infant, exposure to lead can result in developmental delays, a drop in IQ, aggressive behaviour and mood swings. “As lead-poisoned kids reach their teens,” she writes, “they have a much harder time at school and are more likely to drop out.” In their 20s they may be more likely to commit violent crime. Lead may even alter a child’s DNA, so the effects cascade down the generations.

She is at her best when recounting the detective work she undertook after a tip-off about lead levels from a friend who had worked for the Environmental Protection Agency. Her aim was to show that the spike she noticed in lead in her patients’ blood could be traced to the moment Flint changed its water supply. Extracting the relevant data on other residents from unwilling bureaucrats was hard, but eventually Ms Hanna-Attisha got the figures that proved the correlation. On September 24th 2015 she went public with her findings.

Return to Vehicle City

The blowback was immediate. A spokesman for the state’s environment agency said Ms Hanna-Attisha’s conclusions were irresponsible and insisted that Flint’s drinking water was safe. But her evidence was too persuasive to ignore. The scandal ultimately led to criminal prosecutions of numerous officials involved in the key decisions—as well as a switch back to water from Lake Huron in October 2015.

Both books linger on the aftermath. Ms Clark describes a host of lawsuits intended to hold those responsible to account. In a surprisingly big and early victory, in April 2017, the state agreed to pay up to \$87m to replace pipes, and to provide filters and bottled water and conduct water-testing. For her own part, she says in person, Ms Hanna-Attisha is focusing on mitigating the effects on children. Flint has two new child-care centres serving 500 young patients, she notes. She is raising money for a children’s-health charity (it already has \$20m in the kitty) and runs the Flint Registry, a project funded by the Centres for Disease Control and Prevention, which identifies and helps victims of lead-poisoning.

“Flint will not be defined by this crisis,” vows Ms Hanna-Attisha. It brought out the locals’ fighting spirit, she says, and drew attention to their needs. The most important long-term solution, reckons Mayor Weaver, is “jobs, jobs, jobs”. For the first time in more than 30 years, a company is building a factory in town. In October Lear, a maker of car seats, broke ground on a site formerly known as Buick City. ■

Murder most sensational

The room where it happened

Blood & Ivy: The 1849 Murder That Scandalised Harvard. By Paul Collins. *W.W. Norton & Company*; 320 pages; \$26.95 and £21.99

VISITING Boston in 1868, Charles Dickens was asked what he wanted to see most. The room where it happened, Dickens said—by which he meant the scene of a grisly murder that had scandalised the city nearly two decades earlier. The crime had all the ghoulish ingredients of a potboiler: the sudden disappearance of a wealthy landowner and Harvard graduate, George Parkman (pictured); another Harvard man—John Webster, a professor of chemistry and mineralogy—as prime suspect; a dismembered body presumed to be the victim’s; a sullen janitor who supplied the anatomy laboratory with cadavers; and a trial reported in screaming headlines.

In “Blood & Ivy”, Paul Collins ushers readers into that fabled room—and the incestuously tight world of Brahmin Boston. That term refers to a nexus of privileged clans that included the Adams, Cabot and Lodge families. The Brahmins invariably went to Harvard, and in the foggy milieu that Mr Collins entertainingly evokes, suspect, victim, lawyers and many of the witnesses all came from that social subset.

Parkman vanished on the afternoon of November 23rd 1849. Despite a city-wide dragnet, the case hit a dead end until Ephraim Littlefield, a medical-school janitor who lived next to Webster’s college study, hacked his way into the vault under the professor’s rooms and unearthed a pelvis, thigh and lower leg—presumed to be the missing man’s. Webster was arrested and locked up to await trial. The mantle of privilege remained intact, however. While his cellmates dined on slop, the suspect had oysters and cream cakes delivered from Parker’s Restaurant.

The capital trial of a Harvard fellow was a sensation. Only one had ever been executed—George Burroughs, hanged for witchcraft in the 17th century. Though seating was sorely limited, some 7,000 spectators moved in shifts through the courtroom on the first day alone. The event spawned betting pools and merchandising (cough-syrup adverts played on Webster’s background in chemistry). Along with the theatrics, Mr Collins explains, the case was a landmark in the use of forensic science, and for the judge’s elaboration of the notion of guilt “beyond a reasonable doubt”. If, Lemuel Shaw, chief justice of Massachusetts, told the jurors, they “cannot say they feel an abiding conviction, to a moral cer-



Parkman in one piece

tainty of the truth of the charge...the accused is entitled to...an acquittal.”

Although the United States Supreme Court re-examined that definition in 1994, the “Webster charge” remained the classic instruction for juries in Massachusetts until 2015. It is not a spoiler to say that the verdict was more controversial. After all, not only Webster’s life but Harvard’s reputation was at stake. Ivy, it appeared, was not immune to blight. “At such times,” Judge Shaw observed, “the glaze of civilisation and culture shows very thin in spots.” ■

Mughal history

Not just a pretty face

Empress: The Astonishing Reign of Nur Jahan. By Ruby Lal. *W.W. Norton & Company*; 336 pages; \$27.95 and £19.99

THAT India’s Mughal emperors could be devoted to their queens is no surprise. The Taj Mahal, their most famous monument, was a homage to the memory of Mumtaz Mahal, the emperor Shah Jahan’s most-mourned wife. Less well-known is that Mumtaz’s aunt (and Shah Jahan’s step-mother), Nur Jahan, was, for 16 years from 1611, in effect India’s co-ruler.

In fact, according to Ruby Lal’s biography, she became “prime minister as well as empress”. Uniquely for a Mughal woman, her name featured on coins. Not until Indira Gandhi became prime minister in 1966 would India again be ruled by a woman. (Queen Victoria was rather hands-off.)

Not that Nur Jahan has been forgotten. Hers is a household name in South Asia, and her story has been told in at least eight films, several plays and many historical romances. But she is famous for having won the heart of her husband, the emperor Ja- ►►

►hangir, with her beauty, and for using her charm to promote her own interests and her allies'. She came to be seen, in Ms Lal's words, as "a gold-digger and schemer", the "besotted" Jahangir as a "drunk, stoned and oversexed despot".

This cartoonish version is not total fantasy. Nur was Jahangir's 20th and last wife (by his own count; other estimates number his harem in the hundreds). He was indeed a heavy drinker—possibly never fully sober, by one report—and a user of opium. But Ms Lal's meticulous book seeks to show that history has been unfair to Nur Jahan, a woman of many talents and remarkable force of character.

She designed gorgeous gardens and the tomb that became the model for the Taj Mahal itself. She was a great tiger huntress and brilliant shot (a classic portrait shows her tamping down the gunpowder in a musket). She was an accomplished soldier, planning the operation that rescued her husband from a kidnapping. And she was a skilled exponent of the ruthless power politics of the Mughal court, where it was a tradition for princes to rebel against emperor-fathers, and to take no prisoners.

Nur Jahan's accomplishments have been belittled for two reasons. One is that history is written by its victors, and she lost a power struggle on Jahangir's death—to Shah Jahan. To erase her from history, he may even have tried to withdraw the coins that bore her name. Certainly, his official chronicles overlooked her achievements and blamed her for the turmoil that marked the last years of Jahangir's reign.

The second reason is that she was a woman, and as such, according to a guide to conduct popular among the Mughal aristocracy, "it were best...not to come into existence, but, being born, she had better be married or be buried." When Jahangir's great-aunt wanted to make the *haj*, his six-year-old brother was told to escort her: even a little boy was man enough to look after the empire's most senior women.

The great-aunt seems to have bridled, and the boy was left behind. And Nur Jahan's life shows women could soar beyond the harem. Still, both popular myth and serious historiography have conspired to diminish her to a demeaning stereotype, worsened in some Western accounts by Orientalist condescension.

In filling in the details of Nur Jahan's life, Ms Lal has not only written a revisionist feminist biography; she has also provided a vivid picture of the Mughal court, with its luxuries, beauties, intrigues and horrors. Moreover, at a time when India's Hindu-nationalist government chooses to emphasise one strain in the country's history, she offers a reminder of the diversity of Indian tradition. Nur Jahan was a Shia Muslim, but "married a Sunni king who had a Hindu mother and both Hindu and Muslim wives and concubines." ■

Literary posterity

In her prime

On her centenary, Muriel Spark's fiction is more relevant than ever

LIKE Jean Brodie, her greatest creation, Muriel Spark puzzled people as much as beguiling them. She was a Scottish writer who spent most of her life in self-imposed exile in Africa, New York and Italy. She lived in Tuscany with Penelope Jardine, her lifetime companion and literary executor, yet batted off any suggestion that they were lovers. Her novels are mostly short; some were written in the space of six to eight weeks. This brevity annoyed many reviewers (mostly the men). An anonymous critic, writing in 1970 of "The Driver's Seat", a taut psychological thriller, moaned that it "will take you 60 minutes to read and cost you sixpence a minute". But others were entranced.

Spark was born in 1918; to mark her centenary, Polygon, a Scottish imprint, is reissuing all 22 of her novels. Reading them is a corrective to the sentimental view of her that adaptations of her work sometimes encourage. As far-right ideas spread, and misinformation abounds, her books are a piercing reminder of how extreme politics can appeal to the sanest-seeming people—and that half-truths and malfeasance are as intrinsic to human nature as breathing. Spark is a bard of nastiness and lies.

She began writing novels late, at 39. Before then she accumulated experiences—a failed marriage to Sydney Spark in Rhodesia (now Zimbabwe), years in London boarding-houses—that she would mine in her fiction. Once she started, the books came quickly, one every other year or so. An article in the *New Yorker* argued that God was her main character, but there

were many others, and many other subjects: old age and dementia, the Book of Job, Mary Queen of Scots, Lord Lucan, Jerusalem. She wrote about Edinburgh schoolteachers, and about a woman searching for someone to murder her.

Her style was minimal and sharp. She had what her fellow novelist John Updike called a "sweet sting". The sting was administered in precise, unsparing prose. "How little one needs, in the art of writing, to convey the lot," she observed. Rather than go to university—why bother, when she could discuss John Donne as well as any other Edinburgh girl?—she took a course at Heriot-Watt College in precis-writing. That helped shape the economy of her sentences. Meanwhile, she found shorthand was useful when she wanted to eavesdrop, listening in on "chance remarks overheard on a train, in a restaurant".

Her fiction crackedled with conversations. The narrator of "Loitering with Intent" takes a day off work:

I stayed in bed the next morning; about eleven o'clock, when I woke, I telephoned to Halam Street to say I wasn't coming in. Beryl Tims answered the phone. "Have you got a medical certificate?" she said. "Go to hell." "Pardon?" "I'm not ill," I said. "I was out dancing all night, that's all."

"The Prime of Miss Jean Brodie", her sixth book, made Spark's name in 1961. A film starring Maggie Smith followed in 1969 (see picture), as did a Broadway show. In ►►



The crème de la crème

▶ Spark's words, the novel became her "milch cow". Set in Edinburgh in the 1930s, it features an inspiring, infuriating teacher, Jean Brodie, who teaches her girls ("the crème de la crème") to admire Renaissance paintings and Mussolini. Aspects of the character were based on Spark's own schoolteacher, Christina Kay, who in her classroom also displayed a picture of Il Duce's Fascisti marching in Rome, along with reproductions of paintings by da Vinci and Giotto. Like Miss Brodie, Miss Kay took her favourite pupils to afternoon tea and the ballet. Unlike Miss Kay, Miss Brodie has affairs with the music and art teach-

ers, and encourages a wayward schoolgirl to go to Spain to fight for Franco.

The Donmar Theatre in London has staged a new adaptation of the novel this month. As has become customary, it offers a somewhat sanitised version of the story. As played by Lia Williams, Miss Brodie is less the tyrant of the book than a tragic figure. Her abortive love affairs are as prominent as her ultimate betrayal by one of her own pupils. She admires Mussolini, but her respect for "reliable" Hitler has gone. "Women, particularly single women, adore a strong man," Spark told an interviewer in 1979. "There were many in those

days who admired Hitler."

To downplay this aspect of the novel is to miss its seriousness. Such simplifications help create an image of Spark as a twinkly eccentric—as Alan Taylor, a Scottish journalist, sometimes does in "Appointment in Arezzo", his recently published memoir of their friendship. She was rather a woman who could be harsh (she fell out bitterly and publicly with her son), and a novelist who grappled with the clash of good and evil. In "The Prime of Miss Jean Brodie" and elsewhere, hateful views come to seem normal. On her centenary, her work is a warning. ■

Johnson | Fossil hunting

Language can be seen as a record of the past

WHEN stone tools were recently found in China, they were interpreted as proof that the exodus of humans from Africa took place hundreds of thousands of years earlier than was previously thought. The discovery of some hunks of chipped rock illuminated events almost 2m years ago—an intellectual coup for the palaeoanthropologists and geologists who were involved.

Not all fossils are made of stone. For example, at *The Economist's* headquarters in London there is a sign reading "By the lifts"; under it are pinned assorted memos and news reports. There are no lifts nearby. Only those of us familiar with the newspaper's history understand the allusion: such clippings were displayed near the lifts in our previous HQ. Similarly, departments of the paper continue to call themselves "12th floor" and "13th floor", even though they now share the same (sixth) floor in the new building.

Language is full of relics like this, many of them with fascinating stories to tell. That "13th floor" is what is sometimes called an "anachronym": a name that no longer makes sense, because the underlying facts have changed while the language has not. Anachronyms abound. People still "dial" phone numbers, though phones no longer have a dial. They are told to "tune in" to a television show, though TVs no longer have tuners. E-mail's "cc:" feature stands for "carbon copy", though the smelly blue paper that once made instant copies possible is hardly to be found on Gmail.

Clichés and ossified phrases are another way to get a glimpse into a lost past. Take "stuck in a rut". Most people have an idea that a rut is a kind of physical groove, but what kind? The Oxford English Dictionary helpfully explains that the origin is the groove cut by sharp cartwheels in a



soft road. Today, in a world full of soft wheels and hard roads, only metaphorical ruts remain, a reminder of an earlier time. It is a kind of phrasal anachronym.

An anachronym is different from a "retronym". These are words that have had to change because the world has changed around them. A guitar was once a stringed instrument whose hollow wooden body produced its sound. Then someone added magnets and electricity, and the popularity of the electric guitar necessitated a new word for the old thing: the "acoustic" guitar. If you are reading these words on paper, you might consider yourself a fan of "print newspapers", a term that would once have been a tautology but has become, in the era of digital publishing, a necessary retronym.

Much of the gunk and irregularity of language begins to make sense when approached as a kind of fossil hunt. Why does the commonest verb in English—"to

be"—have the wildly irregular conjugation *am-is-are-was-were*? Nobody would design such a verb, and indeed no one did. It is in fact a mash-up of three proto-Germanic roots, one of which produced *am-is-are*, one of which yielded *was-were* (replacing the past tense of the *am-is* group, in a process called suppletion), and one resulting in *be* itself. It is the duck-billed platypus of verbs, an odd hybrid of features. But just as evolutionary biology explains the platypus, historical linguistics shows how the three verbs piled up on each other.

Historical wear and tear often deforms phrases so they seem to be nonsensical. Take the expression—widely used in the discussion of Brexit—"to have your cake and eat it". This is no contradiction at all; one can have and subsequently consume a cake. The point is clearer in the original form: "to eat your cake and have it." In this order, the combination is not possible, and so the cliché makes more sense.

Etymology and the history of language are intriguing in their own right. Who could not love the fact that a "daisy" gets its name from being the "day's eye", because the flower opens in sunlight? But assorted unconnected facts are just that—fleeting arresting cocktail-party diversions. However, when the processes of change fall into regular categories and patterns—retronyms or suppletive verbs like *to be*—they illuminate something bigger. Beneath the illogic of irregular verbs and baffling proverbs is, if not order, at least reason. As a bonus, there are lessons aplenty about the history of human culture more generally.

Kant said that "out of the crooked timber of humanity, no straight thing was ever made." But crooked things can be as lovely as regular ones—and they are often much more interesting.