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Being Human in the Age of Algorithms: part 8

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PREFACE

Настоящее учебное пособие включает актуальные тексты (2017-2018гг.) учебно-познавательной тематики для студентов механико-математического факультета (направления 02.03.01 «Математика и компьютерные науки», 01.03.02 «Прикладная математика и информатика», 38.03.05 «Бизнес-информатика»).

Целью данного пособия является формирование навыка чтения и перевода научно-популярных текстов, а также развитие устной речи студентов (умение выразигь свою точку зрения, дать оценку обсуждаемой проблеме).

Пособие состоит из 5 разделов, рассматривающих значение информационных технологий в современном мире. Каждый из них содержит аутентичные материалы (источники: *Aeon, The Guardian Nautilus*) и упражнения к ним. Раздел “Supplementary reading“ служит материалом для расширения словарного запаса и дальнейшего закрепления навыков работы с текстами по специальности.

Пособие может успешно использоваться как для аудиторных занятий, так и для внеаудиторной практики.

1. How natural is numeracy?

Part 1

<u>Exercise I.</u>

Say what Russian words help to guess the meaning of the following words: naturally, navigate, bananas, product, architecture, block, mathematical, enthusiasm, mystery, anthropological

<u>Exercise II.</u>

Make sure you know the following words and word combinations:

Hard-wired, to endorse, coupling, dizzying, to discern, conundrum, to assertion, contention, endowment, negligible

How natural is numeracy?

Where does our number sense come from? Is it a neural capacity we are born with — or is it a product of our culture?(1)

Why can we count to 152? OK, most of us don't need to stop there, but that's my point. Counting to 152, and far beyond, comes to us so naturally that it's hard not to regard our ability to navigate indefinitely up the number line as something innate, hard-wired into us. Scientists have long claimed that our ability with numbers is indeed biologically evolved – that we can count because counting was a useful thing for our brains to be able to do. The hunter-gatherer who could tell which herd of prey was the biggest, or which tree held the most fruit, had a survival advantage over the one who couldn't. What's more, other animals show a capacity to distinguish differing small quantities of things: two bananas from three, say. Surely it stands to reason, then, that numeracy is adaptive. But is it really? Being able to tell two things from three is useful, but being able to distinguish 152 from 153 must have been rather less urgent for our ancestors. More than about 100 sheep was too many for one shepherd to manage anyway in the ancient world, never mind millions or billions. The cognitive scientist Rafael Núñez of the University of California at San Diego doesn't buy the conventional wisdom that 'number' is a deep, evolved capacity. He thinks that it is a product of culture, like writing and architecture. 'Some, perhaps most, scholars endorse a nativist view that numbers are biologically endowed,' he said. 'But I'd argue that, while there's a biological grounding, language and cultural traits are necessary for the establishment of number itself.' 'The idea of an inherited number sense as the unique building block of complex mathematical skill has had an unusual attraction,' said the neuroscientist Wim Fias of the University of Gent in Belgium. 'It fits the general enthusiasm and hope to expect solutions from biological explanations,' in particular, by coupling 'the mystery of human mind and behaviour with the promises offered by genetic research.' But Fias agrees with Núñez that the available evidence – neuroscientific, cognitive, anthropological – just doesn't support the idea. If Núñez and Fias are right, though, where does our sense of number come from? If we aren't born equipped with the neural capacity for counting, how do we learn to do it? Why do we have the concept of 152? "Understanding number as a quantity is the most essential, most basic part of mathematical knowledge,' explained Fias. Yet numbers seem to be out there in the world, no less than atoms and galaxies; they seem to be pre-existing things just awaiting discovery. The great insights of mathematics, especially in number theory, are simply found to be true (or not). That 32+ 42= 52 is a delightful property of numbers themselves, not an invention of Pythagoras. (2)

Yet whether numbers really exist independently of humans 'is not a scientific debate, but a philosophical, theological or ideological one', said Núñez. 'The claim that, say, five is a prime number independently of humans is not scientifically testable. Such facts are matters of beliefs or faith, and we can have conversations and debates about them but we cannot do science with them.' Still, it seems puzzling that we can figure out these things at all. Geometry and basic arithmetic were handy tools for the ancient builders and lawmakers – 'geometry', after all, means 'measuring the Earth' – but it's hard to see how they served any function as human cognition was evolving over the previous million or more years. There certainly was no biological need to be able to prove Fermat's last theorem, or even to state it in the first place. To explore such dizzying questions of number theory, even the most gifted mathematicians have to start in the same place as the rest of us: by learning to count to 10. To do that, we need to know what numbers are. Once we know that the abstract symbol 'five' equates with the number of fingers on our hand, and that this is one more than the 'four' that equates to the number of legs on a dog, we have the foundations of arithmetic. The capacity to discriminate between different quantities happens extremely quickly in the development of a child – before we even have words to express it. A baby just three or four days old can show by its responses that it can discern the difference between two items and three, and by four months or so babies can grasp that the number of items you get by grouping one of them with another one is the same as two of them. They have a sense of the elementary operation that they will later learn to express as the arithmetic formula 1+1=2. Monkeys, dolphins and dogs can likewise tell which of two groups of food items has more, if the numbers are below 10. Even pigeons 'can be trained to press a certain amount of times on a lever to obtain food', said Fias. Such observations gave rise to what has long been the predominant view that we humans are born with an innate sense of number, says the cognitive neuroscientist Daniel Ansari of the University of Western Ontario in London, Canada. The neuroscientific evidence seemed to offer strong support for that view. Some researchers have concluded that we are born with a 'number module' in our brains: a neural substrate that supports later learning of our culture's symbolic system of representing and manipulating numbers. Not so fast, responds Núñez. Just because a behaviour seems to derive from an innate capacity, that doesn't mean the behaviour is itself innate. Playing tennis makes use of our evolutionary endowment. Most impressively, we can read the trajectory of a ball, sometimes at fantastic speed, so that our racket is precisely where the ball is going to be when it reaches us. But this capacity doesn't mean that our early ancestors evolved to play tennis, or that we have some kind of tennis module in our brains. (3)

Numerical ability is more than a matter of being able to distinguish two objects from three, even if it depends on that ability. No non-human animal has yet been found able to distinguish 152 items from 153. Chimps can't do that, no matter how hard you train them, yet many children can tell you even by the age of five that the two numbers differ in the same way as do the equally abstract numbers 2 and 3: namely, by

1. What seems innate and shared between humans and other animals is not this sense that the differences between 2 and 3 and between 152 and 153 are equivalent (a notion central to the concept of number) but, rather, a distinction based on relative difference, which relates to the ratio of the two quantities. It seems we never lose that instinctive basis of comparison. ‘Despite abundant experience with number through life, and formal training of number and mathematics at school, the ability to discriminate number remains ratio-dependent,’ said Fias. What this means, according to Núñez, is that the brain’s natural capacity relates not to number but to the cruder concept of quantity. ‘A chick discriminating a visual stimulus that has what (some) humans designate as “one dot” from another one with “three dots” is a biologically endowed behaviour that involves quantity but not number,’ he said. ‘It does not need symbols, language and culture.’ ‘Much of the “nativist” view that number is biologically endowed,’ Núñez added, ‘is based on the failure to distinguish at least these two types of phenomena relating to quantity.’ The perceptual rough discrimination of stimuli differing in ‘numerousness’ or quantity, seen in babies and in other animals, is what he calls quantical cognition. The ability to compare 152 and 153 items, in contrast, is numerical cognition. ‘Quantical cognition cannot scale up to numerical cognition via biological evolution alone,’ Núñez said. Although researchers often assume that numerical cognition is inherent to humans, Núñez points out that not all cultures show it. Plenty of pre-literate cultures that have no tradition of writing or institutional education, including indigenous societies in Australia, South America and Africa, lack specific words for numbers larger than about five or six.

Bigger numbers are instead referred to by generic words equivalent to 'several' or 'many'. Such cultures 'have the capacity to discriminate quantity, but it is rough and not exact, unlike numbers', said Núñez. That lack of specificity doesn't mean that quantity is no longer meaningfully distinguished beyond the limit of specific number words, however. If two children have 'many' oranges but the girl evidently has lots more than the boy, the girl might be said to have, in effect, 'many many' or 'really many'. These cultures live with what to us looks like imprecision: it really doesn't matter if, when the oranges are divided up, one person gets 152 and the other 153. And frankly, if we aren't so number-fixated, it really doesn't matter. So why bother having words to distinguish them? (4)

Some researchers have argued that the default way that humans quantify things is not arithmetically – one more, then another one – but logarithmically. The logarithmic scale is stretched out for small numbers and compressed for larger ones, so that the difference between two things and three can appear as significant as the difference between 200 and 300 of them. Attributing more weight to the difference between small than between large numbers makes good sense in the real world, and fits with what Fias says about judging by difference ratios. A difference between families of two and three people is of comparable significance in a household as a difference between 200 and 300 people is in a tribe, while the distinction between tribes of 152 and 153 is negligible. It's easy to read this as a 'primitive' way of reasoning, but anthropology has long dispelled the prejudice. After all, some cultures with few number words might make much more fine-grained linguistic distinctions than we do for, say, smells or family hierarchies. You develop words and concepts for what truly matters to your society. Building on the clues from anthropology, neuroscience can tell us additional details about the origin of quantity discrimination. Brain-imaging studies have revealed a region of the infant brain involved in this task – distinguishing two dots from three, say. This ability truly does seem to be innate, and researchers who argue for a biological basis of number have claimed that children recruit these neural resources when they start to learn their culture's symbolic system of numbers. Even though no one can distinguish 152 from 153 randomly spaced dots visually (that is, without counting), the argument is that the basic cognitive apparatus for doing so is the same as that used to tell 2 from 3. But that appealing story doesn't accord with the latest evidence. Surprisingly, when you look deeply at the patterns of brain activation, we and others found quite a lot of evidence to suggest a large amount of dissimilarity between the way our brains process non-symbolic numbers, like arrays of dots, and symbolic numbers. They don't seem to be correlated with one another. That challenges the notion that the brain mechanisms for processing culturally invented number symbols maps on to the non-symbolic number system. These systems are not as closely related as we thought. If anything, the evidence now seems to suggest that the cause-and-effect relationship works the other way: 'When you learn symbols, you start to do these dot-discrimination tasks differently.' This picture makes intuitive sense when you consider how hard kids have to work to grasp numbers as opposed to quantities. 'One thing I've always struggled with is that on the one hand we have evidence that infants can discriminate quantity, but on the other hand it takes children between two to three years to learn the relationship between number words and quantities,' he said. 'If we thought there was a very strong innate basis on to which you just map the symbolic system, why should there be such a protracted developmental trajectory, and so much practice and explicit instruction necessary for that?' (5)

But the apparent disconnect between the two types of symbolic thought raises a mystery of its own: how do we grasp number at all if we have only the cognitive machinery for the cruder notion of quantity? That conundrum is one reason why some researchers can't accept Núñez's claim that the concept of number is a cultural trait, even if it draws on innate dispositions. 'The brain, a biological organ with a genetically defined wiring scheme, is predisposed to acquire a number system,' said the neurobiologist Andreas Nieder. 'Culture can only shape our number faculty within the limits of the capacities of the brain. Without this predisposition, number symbols would lie forever beyond our grasp.' Perhaps what we draw on, he thinks, is not a simple symbol-to-quantity mapping, but a sense of the relationships between numbers – in other words, a notion of arithmetical rules rather than just a sense of number-line ordering. 'Even when children understand the mapping of number symbols to quantities, they don't necessarily understand that if you add one more, you get to the next highest number,'he said. 'Getting the idea of number off the ground turns out to be extremely complex, and we're still scratching the surface in our understanding of how this works.' The debate over the origin of our number sense might itself seem rather abstract, but it has tangible practical consequences. Most notably, beliefs about the relative roles of biology and culture can influence attitudes toward mathematical education. The nativist view that number sense is biological seemed to be supported by researchers at the Johns Hopkins University in Baltimore. The study showed 14-year-old test subjects' ability to discriminate at a glance between exact numerical quantities (such as the number of dots in an image) correlated with their mathematics test scores going back to kindergarten. In other words, if you're inherently good at assessing numbers visually, you'll be good at maths. But Fias says that such tests of supposedly innate discrimination between numbers of things aren't as solid as they might seem. It's impossible to separate out the effects of the number of dots from factors such as their density, areal coverage and brightness. Furthermore, many studies show that arithmetic skill is more closely linked to learning and understanding of number symbols (1, 2, 3…) than to an ability to discriminate numbers of objects visually. (6)

As much as educators (and the researchers themselves) desire firm answers, the truth is that the debate about the origin of numerical cognition is still wide open. Nieder remains convinced that 'our faculty for symbolic number, no matter how much more elaborate than the non-symbolic capacity of animals, is part of our biological heritage'. He feels that Núñez's assertion that numbers themselves are cultural inventions 'is beyond the reach of experimental investigation, and therefore irrelevant from a scientific point of view'. But if Núñez is right that the concept of number is a cultural elaboration of a much cruder biological sense of quantity, that raises new and intriguing questions about mathematics in the brain. How and why did we decide to start counting? Did it begin when we could name numbers, perhaps? 'Language in itself may be a necessary condition for number, but it is not sufficient for it,' said Núñez. ‘All known human cultures have language, but by no means all have exact quantification in the form of number.’ ‘How and when the transition from quantical to numerical thinking happened is hard to unravel,’ said Andrea Bender, a cognitive scientist at the University of Bergen in Norway, ‘especially if one assumes that language played a pivotal role in this process, because we don’t even know when language emerged. All research seems to indicate that one needs to have culture before one can understand number concepts.’ Some archaeologists date numerical thinking back to a few tens of thousands of years ago, Bender said, based on material remains such as notched bones – ‘but this is speculative to some extent’. Further complicating things, when different cultures developed the concept of number, they came up with varying solutions of how best to count. Although many Western languages count in base 10 – probably guided by the number of digits on our hands – they typically have a language rooted in a base-12 calendar, so that only at 13 (‘three-ten’) do the number words become composite. But we could have adopted a different number system altogether. Take the people of the small island of French Polynesia. Bender and her coworkers found that the Mangarevans use a counting system that is a mixture of the familiar decimal system and another that is equivalent to binary. That might have seemed a peculiar choice before the digital age, which has made binary seem, well, perfectly logical. But which number system works best depends on what you want to do with numbers, Bender says. For certain arithmetical operations involved in the distribution of food and provisions in Polynesian society, binary can be simpler to use. In this setting, at least, it’s a good solution to a cultural problem. ‘ Polynesian cultures seem to be great examples of inventing counting systems because they were more efficient for the tasks at hand,’ Bender said. She believes that her findings support Núñez’s contention that, although humans have biological, evolved preconditions for numerical cognition, ‘the tools they need and invent are a product of culture, and hence are diverse’. Perhaps at the root of the impassioned disputes over number sense is a desire to valorise certain traits and capacities – not just mathematics, but also art and music – by giving them a naturalistic imprimatur of biology, as if they would be somehow diminished otherwise. The idea that a grand mental capacity comes from our culture – that we conjured up something beyond our immediate biological endowment, through the sheer power of thought – seems rather ennobling, not dismissive. Perhaps we should give ourselves more credit. (7)

Adapted from Aeon

Exercise III.

Find paragraphs, dealing with the following: concept, galaxies, pre-existing, insights, debate, prime, faith, handy, dizzying, abstract

Exercise IV.

Fill in the gaps.

1. They need to not only …................................. the plan but start discussing how to help fund it.
2. The implications-for politics, for education, for global economics-are …...................................
3. Faith serves as a filter, helping us …....................... what is important and what is not.

4. Varying cultures of ……………………… peoples lived in the area for thousands of years.
5. All of these things can seem like ………………………… expenditures on a day to day basis.
6. There is no easy way out of resolving this ……………………, but it must be confronted.
7. There, he developed a reputation as a bright lawyer with a friendly ………………………………
8. Scientists'current efforts only ……………………… of what's needed, however.
9. Whitmore declined to …………………………. on the evidence due to the ongoing investigation.
10. Either turn over the ……………………… or cut it loose from sucking the state budget dry.

Exercise V.

Make up sentences of your own with the following word combinations:

if anything, to get off the ground, to scratch the surface, to conjure up , beyond biological endowment, through the sheer power of thought, by no means, to come up with

Exercise VI.

Match the words to the definitions in the column on the right:

capacity	especially; in particular
neural	originating or occurring naturally in a particular place; native
pivotal	an animal that is hunted and killed by another for food

elaborate	express or measure the quantity of
disposition	the maximum amount that something can contain
indigenous	of or relating to a nerve or the nervous system
prey	characteristic of or relating to a class or group of things; not specific
notably	central and important
to quantify	containing a lot of careful detail or many detailed parts:
generic	the way in which something is placed or arranged, esp. in relation to other things

Exercise VII.

Summarize the article "How natural is numeracy?"

Part 2

Exercise I.

Identify the part of speech the words belong to.
operation, arithmetic, formula, observations, predominant, fantastic , precisely, capacity, ancestors, module.

Exercise II.

Form verbs from the following words: urgent(1), establishment (1), explanation (1), testable (1), beliefs(1), discrimination(3), investigation (4), distribution (4)

Exercise III.

Find synonyms to the following words. Translate them into Russian:

food (7), distribution (7), calendar (7), count (7), sufficient (7), condition (7), reach (7), heritage (7), origin (7), debate (7), desire (7)

Exercise IV.

Find antonyms to the following words. Translate them into Russian:

solid (6), discrimination (6), innate (6), support (7), dispute (7), diverse (7), grand (7), dismissive (7), immediate (7), truth (7)

Exercise V.

Match the words to make word combinations:

genetic	sense
mathematical	capacity
building	world
cultural	wisdom
biological	mind
conventional	research
ancient	skill
neural	block
number	traits
human	grounding

2. Is the world really better than ever?

Part 1

Exercise I.

Say what Russian words help to guess the meaning of the following words: pessimism, cynical, principle, commentators, immune, proportion, global, emissions, pandas, electricity

Exercise II.

Make sure you know the following words and word combinations: self-indulgent, ingenuity, compelling, sanitation, to nestle, implication, betterment, imminent, irredeemable, surge,

Is the world really better than ever?

The headlines have never been worse. But an increasingly influential group of thinkers insists that humankind has never had it so good – and only our pessimism is holding us back.(1)

By the end of last year, anyone who had been paying even passing attention to the news headlines was highly likely to conclude that everything was terrible, and that the only attitude that made sense was one of profound pessimism – tempered, perhaps, by cynical humour, on the principle that if the world is going to hell in a handbasket, one may as well try to enjoy the ride. Yet one group of increasingly prominent commentators has seemed uniquely immune to the gloom. In December, in an article headlined "Never forget that we live in the best of times", the Times columnist Philip Collins provided an end-of-year summary of reasons to be cheerful: the proportion of the world’s population living in extreme poverty had fallen below 10% for the first time; global carbon emissions had failed to rise for the third year running; the death penalty had been ruled illegal in more than half of all countries – and giant pandas had been removed from the endangered species list. (2)

In the New York Times, Nicholas Kristof declared that by many measures, “it was the best year in the history of humanity”, with falling global inequality, child mortality roughly half what it had been as recently as 1990, and 300,000 more people gaining access to electricity each day and celebrating the promise of artificial intelligence and free trade. The growing collection of pundits and academics who endorse this stubbornly cheerful account of our situation have occasionally been labelled “the New Optimists”. And from their perspective, our prevailing mood of despair is irrational, and frankly a bit self-indulgent. They argue that it says more about us than it does about how things really are – illustrating a certain tendency toward collective self-flagellation, and an unwillingness to believe in the power of human ingenuity. “Once upon a time, it was of great survival value to be worried about everything that could go wrong,” says Johan Norberg, a historian and self-declared New Optimist. This is what makes bad news especially compelling: in our evolutionary past, it was a very good thing that your attention could be easily seized by negative information, since it might well indicate an imminent risk to your own survival. (The cave-dweller who always assumed there was a lion behind the next rock would usually be wrong – but he’d be much more likely to survive and reproduce than one who always assumed the opposite.) But that was all before newspapers, television and the internet: in these hyper-connected times, our addiction to bad news just leads us to vacuum up depressing or enraging stories from across the globe, whether they threaten us or not, and therefore to conclude that things are much worse than they are. Really good news, on the other hand, can be a lot harder to spot – partly because it tends to occur gradually. And you'll rarely see a headline about a bad event that failed to occur. (3)

In his book, Norberg canters through 10 of the most important basic indicators of human flourishing – food, sanitation, life expectancy, poverty, violence, the state of the environment, literacy, freedom, equality and the conditions of childhood. And he takes special pleasure in squelching the fantasies of anyone inclined to wish they had been born a couple of centuries back. As recently as 1882, only 2% of homes in New York had running water; in 1900, worldwide life expectancy was a paltry 31, thanks both to early adult death and rampant child mortality. Today, by contrast, it's 71 – and those extra decades involve far less suffering, too. The New Optimists invite us to forget our cherished theories about what is wrong with the world and what should be done about it, and breathe, instead, the refreshing air of objective fact. The data doesn't lie. Just look at the numbers! But numbers, it turns out, can be as political as anything else. The New Optimists are certainly right on the nostalgia front: nobody in their right mind should wish to have lived in a previous century. In a 2015 survey for YouGov, 65% of British people (and 81% of the French) said they thought the world was getting worse – but judged according to numerous sensible metrics, they're simply wrong. People are indeed rising out of extreme poverty at an extraordinary rate; child mortality really has plummeted; standards of literacy, sanitation and life expectancy have never been higher. The average European or American enjoys luxuries medieval potentates literally couldn't have imagined. Besides we are living in history's most peaceful era, with violence of all kinds – from deaths in war to schoolyard bullying – in steep decline. But the New Optimists aren't primarily interested in persuading us that human life involves a lot less suffering than it did a few hundred years ago. (Even if you're a pessimist, you probably didn't need convincing of that fact.) Nestled inside that essentially indisputable claim, there are several more controversial implications. For example: that since things have so clearly been improving, we have good reason to assume they will continue to improve. And further – though this is a claim only sometimes made explicit in the work of the New Optimists – that whatever we've been doing these past decades, it's clearly working, and so the political and economic arrangements that have brought us here are the ones we ought to stick with. Optimism, after all, means more than just believing that things aren't as bad as you imagined: it means having justified confidence that they will be getting even better soon. "Rational optimism holds that the world will pull out of the current crisis," Ridley wrote after the financial crisis of 2007-8, "because of the way that markets in goods, services and ideas allow human beings to exchange and specialise for the betterment of all … I am a rational optimist: rational, because I have arrived at optimism by looking at the evidence." If all this were really true, it would suggest that an overwhelming proportion of the energy we dedicate to debating the state of humanity – all the political outrage, the warnings of imminent disaster, all our anxiety and guilt about the misery afflicting people all over the world – is wasted. Or, worse, it might be counterproductive, insofar as a belief that things are irredeemably awful seems like a bad way to motivate people to make things better, and thus in danger of becoming a self-fulfilling prophecy. "Here are the facts," wrote the American economist Julian Simon. "On average, people throughout the world have been living longer and eating better than ever before. Fewer people die of famine nowadays than in earlier centuries … every single measure of material and environmental welfare in the United States has improved rather than deteriorated. This is also true of the world taken as a whole. All the long-run trends point in exactly the opposite direction from the projections of the doomsayers." Those are the facts. So why aren't we all New Optimists now? (4)

Even if it's true that everything really is so much better than ever, why assume things will continue to improve? Improvements in sanitation and life expectancy can't prevent rising sea levels destroying your country. And it's dangerous, more generally, to predict future results by past performance: view things on a sufficiently long timescale, and it becomes impossible to tell whether the progress the New Optimists celebrate is evidence of history's steady upward trajectory, or just a blip. Almost every advance Norberg champions in his book, for example, took place in the last 200 years – a fact that the optimists take as evidence of the unstoppable potency of modern civilisation, but which might just as easily be taken as evidence of how rare such periods of progress are. Humans have been around for 200,000 years; extrapolating from a 200-year stretch seems unwise. We risk making the mistake of the 19th-century British historian Henry Buckle, who confidently declared, in his book History of Civilization in England, that war would soon be a thing of the past. (5)

But the real concern here is not that the steady progress of the last two centuries will gradually swing into reverse, plunging us back to the conditions of the past; it's that the world we have created – the very engine of all that progress – is so complex and unpredictable that catastrophe might befall us at any moment. Steven Pinker may be absolutely correct that fewer and fewer people are resorting to violence to settle their disagreements, but it only takes a single angry narcissist in possession of the nuclear codes to spark a global disaster. Digital technology has unquestionably helped fuel a worldwide surge in economic growth, but if cyberterrorists use it to bring down the planet's financial infrastructure next month, that growth might rather swiftly become moot. "The point is that if something does go seriously wrong in our societies, it's really hard to see where it stops," says David Runciman, professor of politics at Cambridge University, who has debated New Optimists such as Ridley and Norberg. "The thought that, say, the next financial crisis, in a world as interconnected and algorithmically driven as our world, could simply spiral out of control – that is not an irrational thought. Which makes it quite hard to be that optimistic." When you live in a world where everything seems to be getting better, yet it could all collapse tomorrow, "it's perfectly rational to be freaked out." (6)

The New Optimists promise a way to feel about the state of the world based on the way it really is. But after steeping yourself in their work, you begin to wonder if all their upbeat factoids really do speak for themselves. For a start, why assume that the correct comparison to be making is the one between the world as it was, say, 200 years ago, and the world as it is today? Of course things are better than they were. But they're surely nowhere near as good as they ought to be. To pick some obvious examples, humanity has the capacity to eliminate extreme poverty, end famines, or radically reduce human damage to the climate. But we've done none of these, and the fact that things aren't as terrible as they were in 1800 is beside the point. If you start from the fact that plague victims once languished in the streets of European cities, it's natural to conclude that life these days is wonderful. But if you start from the position that we could have eliminated famines, or reversed global warming, the fact that such problems persist may provoke a different kind of judgment. The argument that we should be feeling happier than we are because life on the planet as a whole is getting better, on average, also misunderstands a fundamental truth about how happiness works: our judgments of the world result from making specific comparisons that feel relevant to us, not on adopting what David Runciman refers to as "the view from outer space". If people in your small American town are far less economically secure than they were in living memory, or if you're a young British person facing the prospect that you might never own a home, it's not particularly consoling to be told that more and more Chinese people are entering the middle classes. At its heart, the New Optimism is an ideological argument: broadly speaking, its proponents are advocates for the power of free markets, and they intend their sunny picture of humanity's recent past and future to vindicate their politics. It's still a political argument, not a straightforward, neutral reliance on objective facts and it makes just as much sense to adopt the opposite view. “ Perhaps it is the one genuinely indisputable truth on which the New Optimists and the more pessimistically minded can agree: that whatever happens, things could always, in principle, have been worse. (7)

Adapted from The Guardian

Exercise III.

Find paragraphs, dealing with the following: pundit, to canter, to squelch, paltry, steep, trade, pundits, mood, self-flagellation, imminent

Exercise IV.

Fill in the gaps.

1. You raise the idea that your work could have …........................... implications for science.
2. Understandably, the interplay between religion and science is a …........................... theme.
3. Bayh is not the only politician or …............................. to issue this warning in recent months.
4. 4) Creative leaders unlock........................... and build support for change by lightening up.
5. The site was fully interactive, enabling visitors to …............................... in a number of ways.
6. Mr. Kostov on taking office made exactly the same promises to …........................... corruption.
7. The …............................ is, once they learn, it can then be left to themselves to do it.

8. Never mind the progress of society and the.............................. of the people as a whole.
9. Still, the sense of …...................... loss at the end is true enough and persistent.
10. The atmosphere inside the academy building on Saturday was …...............................and energetic.

<u>Exercise V</u> .

Make up sentences of your own with the following word combinations:

to go to hell in a hand basket, freaked out, in so far, from one's perspective

<u>Exercise VI</u>.

Match the words to the definitions in the column on the right:

upbeat	clear (someone) of blame or suspicion
profound	jump or dive quickly and energetically
gloom	declare one's public approval or support of
prominent	take hold of suddenly and forcibly
tempered	a state of depression or despondency
to engage	cheerful; optimistic
to endorse	occupy, attract, or involve (someone's interest or attention)

to seize	at, from, or extending to a great depth; very deep
plunge	situated so as to catch the attention; noticeable
to vindicate	serve as a neutralizing or counterbalancing force to (something)

<u>ExerciseVII</u>.

Summarize the article “Is the world really better than ever?”

Part 2

<u>Exercise I.</u>

Identify the part of speech the words belong to.

survival, cave-dweller, opposite, television, threaten, gradually, rarely, occur

<u>Exercise II.</u>

Form nouns from the following words:

conclude(1), declared (1), measures (1), illustrating (1), collective (1), indicate (1), reproduce (1), important(1), sensible (2), financial (2)

<u>Exercise III.</u>

Find synonyms to the following words. Translate them into Russian:

awful (4), warning (4), disaster (4), outrage (4), dedicate (4), overwhelming (4), state (4), crisis (4), exchange (7), argument (7)

<u>Exercise IV.</u>

Find antonyms to the following words. Translate them into Russian:

stop (6), poverty (7), extreme (7), persist (7), provoke (7), outer (7), middle (7), secure (7), neutral (7), indisputable (7)

Exercise V.

Match the words to make word combinations:

endangered	population
child	summary
endangered species	pandas
death	humour
carbon	mortality
world's	pessimism
end-of-year	species
cynical	list
profound	emissions
giant	penalty

3. Escape the echo chamber

Part 1

Exercise I.

Say what Russian words help to guess the meaning of the following words: intellectual, basic, foundational, phenomena, systematically, exclude, taxonomy, relevant, contact, interests

Exercise II.

Make sure you know the following words and word combinations.

inadvertent, malignant, superbly, outright, to alienate, ramshackle, resilient, blatant, unswayed, wrought

Escape the echo chamber

First you don't hear other views. Then you can't trust them. Your personal information network entraps you just like a cult (1)

Something has gone wrong with the flow of information. It's not just that different people are drawing subtly different conclusions from the same evidence. It seems like different intellectual communities no longer share basic foundational beliefs. Maybe nobody cares about the truth anymore, as some have started to worry. Maybe political allegiance has replaced basic reasoning skills. Maybe we've all become trapped in echo chambers of our own making – wrapping ourselves in an intellectually impenetrable layer of likeminded friends and web pages and social media feeds. But there are two very different phenomena at play here, each of which subvert the flow of information in very distinct ways. Let's call them echo chambers and epistemic bubbles. Both are social structures that systematically exclude sources of information. Both exaggerate their members' confidence in their beliefs, but they work in entirely different ways. An epistemic bubble is when you don't hear people from the other side. An echo chamber is what happens when you don't trust people from the other side. Current usage has blurred this crucial distinction, so let me introduce a somewhat artificial taxonomy. An 'epistemic bubble' is an informational network from which relevant voices have been excluded by omission. That omission might be purposeful: we might be selectively avoiding contact with contrary views because, say, they make us uncomfortable. As social scientists tell us, we like to engage in selective exposure, seeking out information that confirms our own worldview. But that omission can also be entirely inadvertent. Even if we're not actively trying to avoid disagreement, our Facebook friends tend to share our views and interests. When we take networks built for social reasons and start using them as our information feeds, we tend to miss out on contrary views and run into exaggerated degrees of agreement. An 'echo chamber' is a social structure from which other relevant voices have been actively discredited. Where an epistemic bubble merely omits contrary views, an echo chamber brings its members to actively distrust outsiders. In their book Echo Chamber: Rush Limbaugh and the Conservative Media Establishment, Kathleen Hall Jamieson and Frank Cappella offer a groundbreaking analysis of the phenomenon. For them, an echo chamber is something like a cult. A cult isolates its members by actively alienating them from any outside sources. Those outside are actively labelled as malignant and untrustworthy. A cult member's trust is narrowed, aimed with laser-like focus on certain insider voices. In epistemic bubbles, other voices are not heard; in echo chambers, other voices are actively undermined. The way to break an echo chamber is not to wave "the facts" in the faces of its members. It is to attack the echo chamber at its root and repair that broken trust. (2)

Let's start with epistemic bubbles. They have been in the limelight lately, most famously in Eli Pariser's The Filter Bubble. The general gist: we get much of our news from Facebook feeds and similar sorts of social media. Our Facebook feed consists mostly of our friends and colleagues, the majority of whom share our own political and cultural views. We visit our favourite like-minded blogs and websites. At the same time, various algorithms behind the scenes, such as those inside Google search, invisibly personalise our searches, making it more likely that we'll see only what we want to see. These processes all impose filters on information. Such filters aren't necessarily bad. The world is overstuffed with information, and one can't sort through it all by oneself: filters need to be outsourced. That's why we all depend on extended social networks to deliver us knowledge. But any such informational network needs the right sort of broadness and variety to work. Each individual person in my network might be superbly reliable about her particular informational patch but, as an aggregate structure, my network lacks what Sanford Goldberg in his book Relying on Others calls 'coverage-reliability'. It doesn't deliver to me a sufficiently broad and representative coverage of all the relevant information. Epistemic bubbles also threaten us with a second danger: excessive self-confidence. In a bubble, we will encounter exaggerated amounts of agreement and suppressed levels of disagreement. We're vulnerable because, in general, we actually have very good reason to pay attention to whether other people agree or disagree with us. Looking to others for corroboration is a basic method for checking whether one has reasoned well or badly. But not all forms of corroboration are meaningful. Ludwig Wittgenstein says: imagine looking through a stack of identical newspapers and treating each next newspaper headline as yet another reason to increase your confidence. This is obviously a mistake. The fact that The New York Times reports something is a reason to believe it, but any extra copies of The New York Times that you encounter shouldn't add any extra evidence. But outright copies aren't the only problem here. Suppose that I believe that the Paleo diet is the greatest diet of all time. I assemble a Facebook group called 'Great Health Facts!' and fill it only with people who already believe that Paleo is the best diet. The fact that everybody in that group agrees with me about Paleo shouldn't increase my confidence level one bit. They're not mere copies – they actually might have reached their conclusions independently – but their agreement can be entirely explained by my method of selection. The group's unanimity is simply an echo of my selection criterion. It's easy to forget how carefully pre-screened the members are, how epistemically groomed social media circles might be. (3)

Luckily, though, epistemic bubbles are easily shattered. We can pop an epistemic bubble simply by exposing its members to the information and arguments that they've missed. But echo chambers are a far more pernicious and robust phenomenon. Jamieson and Cappella's book is the first empirical study into how echo chambers function. In their analysis, echo chambers work by systematically alienating their members from all outside epistemic sources. Their research centres on

Rush Limbaugh, a wildly successful conservative firebrand in the United States, along with Fox News and related media. Limbaugh uses methods to actively transfigure whom his listeners trust. His constant attacks on the 'mainstream media' are attempts to discredit all other sources of knowledge. He systematically undermines the integrity of anybody who expresses any kind of contrary view. And outsiders are not simply mistaken – they are malicious, manipulative and actively working to destroy Limbaugh and his followers. The resulting worldview is one of deeply opposed force, an all-or-nothing war between good and evil. Anybody who isn't a fellow Limbaugh follower is clearly opposed to the side of right, and therefore utterly untrustworthy. The result is a rather striking parallel to the techniques of emotional isolation typically practised in cult indoctrination. According to mental-health specialists in cult recovery cult indoctrination involves new cult members being brought to distrust all non-cult members. This provides a social buffer against any attempts to extract the indoctrinated person from the cult. (4)

The echo chamber doesn't need any bad connectivity to function. Limbaugh's followers have full access to outside sources of information. According to Jamieson and Cappella's data, Limbaugh's followers regularly read – but do not accept – mainstream and liberal news sources. They are isolated, not by selective exposure, but by changes in who they accept as authorities, experts and trusted sources. They hear, but dismiss, outside voices. Their worldview can survive exposure to those outside voices because their belief system has prepared them for such intellectual onslaught. In fact, exposure to contrary views could actually reinforce their views. Limbaugh might offer his followers a conspiracy theory: anybody who criticises him is doing it at the behest of a secret cabal of evil elites, which has already seized control of the mainstream media. His followers are now protected against simple exposure to contrary evidence. In fact, the more they find that the mainstream media calls out Limbaugh for inaccuracy, the more Limbaugh's predictions will be confirmed. Perversely, exposure to outsiders with contrary views can thus increase echo-chamber members' confidence in their insider sources, and hence their attachment to their worldview. What's happening is a kind of intellectual judo, in which the power and enthusiasm of contrary voices are turned against those contrary voices through a carefully rigged internal structure of belief. One might be tempted to think that the solution is just more intellectual autonomy. Echo chambers arise because we trust others too much, so the solution is to start thinking for ourselves. But that kind of radical intellectual autonomy is a pipe dream. If the philosophical study of knowledge has taught us anything in the past half-century, it is that we are irredeemably dependent on each other in almost every domain of knowledge. Think about how we trust others in every aspect of our daily lives. Driving a car depends on trusting the work of engineers and mechanics; taking medicine depends on trusting the decisions of doctors, chemists and biologists. Even the experts depend on vast networks of other experts. A climate scientist analysing core samples depends on the lab technician who runs the air-extraction machine, the engineers who made all those machines, the statisticians who developed the underlying methodology, and on and on. As Elijah Millgram argues in The Great Endarkenment, modern knowledge depends on trusting long chains of experts. And no single person is in the position to check up on the reliability of every member of that chain. Ask yourself: could you tell a good statistician from an incompetent one? A good biologist from a bad one? A good nuclear engineer or macro-economist, from a bad one? Any particular reader might, of course, be able to answer positively to one or two such questions, but nobody can really assess such a long chain for herself. Instead, we depend on a vastly complicated social structure of trust. We must trust each other, but that trust makes us vulnerable. Most of the examples I've given so far, following Jamieson and Cappella, focus on the conservative media echo chamber. But nothing says that this is the only echo chamber out there. (5)

Unfortunately, much of the recent analysis has lumped epistemic bubbles together with echo chambers into a single, unified phenomenon. But it is absolutely crucial to distinguish between the two. Epistemic bubbles are rather ramshackle; they go up easily, and they collapse easily, too. Echo chambers can start to seem almost like living things. Their belief systems provide structural integrity, resilience and active responses to outside attacks. Surely a community can be both at once, but the two phenomena can also exist independently. And of the events we're most worried about, it's the echo-chamber effects that are really causing most of the trouble. Crucially, echo chambers can offer a useful explanation of the current informational crisis in a way that epistemic bubbles cannot. Many people have claimed that we have entered an era of 'post-truth'. Not only do some political figures seem to speak with a blatant disregard for the facts, but their supporters seem utterly unswayed by evidence. It seems, to some, that truth no longer matters. This is an explanation in terms of total irrationality. To accept it, you must believe that a great number of people have lost all interest in evidence or investigation, and have fallen away from the ways of reason. The phenomenon of echo chambers offers a far more modest explanation. The apparent 'post-truth' attitude can be explained as the result of the manipulations of trust wrought by echo chambers. We don't have to attribute a complete disinterest in facts, evidence or reason to explain the post-truth attitude. In many ways, echo-chamber members are following reasonable and rational procedures of enquiry. They're engaging in critical reasoning. They're questioning, they're evaluating sources for themselves, they're assessing different pathways to information. They are critically examining those who claim expertise and trustworthiness, using what they already know about the world. It's simply that their basis for evaluation – their background beliefs about whom to trust – are radically different. They are not irrational, but systematically misinformed about where to place their trust. Once an echo chamber starts to grip a person, its mechanisms will reinforce themselves. In an epistemically healthy life, the variety of our informational sources will put an upper limit to how much we're willing to trust any single person. But inside an echo chamber, that upper ceiling disappears. Being caught in an echo chamber is not always the result of laziness or bad faith. Imagine, for instance, that somebody has been raised and educated entirely inside an echo chamber. That child has been taught the beliefs of the echo chamber, taught to trust the TV channels and websites that reinforce those same beliefs. It must be reasonable for a child to trust in those that raise him. So, when the child finally comes into contact with the larger world – say, as a teenager – the echo chamber's worldview is firmly in place. That teenager will distrust all sources outside her echo chamber, and he will have gotten there by following normal procedures for trust and learning. The worry is that he's intellectually trapped. Is there anything we can do, then, to help an echo-chamber member to reboot? We've already discovered that direct assault tactics – bombarding the echo-chamber member with 'evidence' – won't work. Echo-chamber members are not only protected from such attacks, but their belief systems will judo such attacks into further reinforcement of the echo chamber's worldview. Instead, we need to restore trust in some outside voices. This path is not the one an echo-chamber member can trigger on his own; it is only a whisper-thin hope for rescue from the outside. (6)

Adapted from Aeon

Exercise III.

Find paragraphs, dealing with the following: reboot onslaught, voices, groundbreaking, cult, malignant, laser-like, epistemic, root, limelight

Exercise IV.

Fill in the gaps.

1. Toyota has identified floor mats that can …............................... a car's gas pedal as one cause of sudden acceleration.
2. A British subject resident abroad also continues to owe …............................ to the Crown.
3. It represents all that is …................................ about who people are and what they think.
4. Their families have said if they crossed the border at all, it was …................................

5. Don't flatter yourself that you're immune to the................................ power of the group.
6. A more …............................... method for verifying identity would almost certainly reduce fraud.
7. It seems such a short sighted marketing plan may …............................ future customers.
8. There was an account of psychology that was taken to show man as............................... selfish.
9. Preparing for this eventuality would make the existing euro area more................................
10. If your system has been compromised, it is designed to fix itself with a …..

Exercise V.

Make up sentences of your own with the following word combinations:

to put an upper limit to , to come into contact , to share basic foundational beliefs, basic reasoning skills

Exercise VI .

Match the words to the definitions in the column on the right:

to shatter	catch (someone or something) in or as in a trap
behest	harm the good reputation of (someone or something)
robust	a person who causes political or social trouble by opposing authority

	and encouraging others to do so
to subvert	a secret political clique or faction
to entrap	the substance or essence of a speech or text
to discredit	a physical attack
firebrand	break or cause to break suddenly and violently into pieces
cabal	a person's orders or command
gist	(of a person, animal, or plant) strong and healthy; vigorous
assault	undermine the power and authority of (an established system or institution)

Exercise VII.

Summarize the article “Escape the echo chamber”

Part 2

Exercise I.

Identify the part of speech the words belong to.

impenetrable, epistemic, corroboration, pernicious, irredeemably, endarkment, indoctrination, integrity, allegiance, perversely

Exercise II.

Form adjectives from the following words: intellectually (2), systematically (2), confidence (2), entirely (2), distinction (2), selectively (2), reliability (5), irrationality (6), crucially (6), independently (6)

Exercise III.

Find synonyms to the following words. Translate them into Russian: incompetent (5), unfortunately (6), collapse (6), current (6), irrationality (6), apparent (6), modest (6), sources (6), willing (6), assault (6)

Exercise IV.

Find antonyms to the following words. Translate them into Russian: intellectual (2), protect (2), reasonable (6), systematical (6), irrational (6), misinform (6), belief (6), trust (6), restore (6), rescue (6)

Exercise V.

Match the words to make word combinations:

pipe	friends
social	allegiance
impenetrable	media
likeminded	chamber
personal	pages
reasoning	layer

political	dream
intellectual	information
echo	skills
web	communities

4. Why Fake Data When You Can Fake a Scientist?

Part 1

<u>Exercise I.</u>

Say what Russian words help to guess the meaning of the following words: bioinformatics, doctorate, mark, experiment, satirical, biochemistry, molecular, popular, comedian , vaccines.

<u>Exercise II.</u>

Make sure you know the following words and word combination credentials, to lament, self-serving, bogus, crummy, compromised, floodgate, cohort, stuffing, surge,

Why Fake Data When You Can Fake a Scientist?

When scientists misbehave, the culture of 'publish or perish' is often blamed. Some researchers cut corners, massage data and images or invent results to secure academic papers and the rewards that come with them. The most common cause of an offence used to be a lack of attention, prompted, among other things, by being too busy and trying to juggle too many projects. Now making up names and CVs is one of the tricks to game scientific metrics.(1)

Hoss Cartwright, a former editor of the International Journal of Agricultural Innovations and Research, had a good excuse for missing the 5th World Congress on Virology last year: He doesn't exist. Burkhard Morgenstern, a professor of bioinformatics at the University of Göttingen, dreamt him up, and built a nice little scientific career for him. He wrote Cartwright a Curriculum Vitae, describing his doctorate in

Studies of Dunnowhat, his rigorous postdoctoral work at Some Shitty Place in the Middle of Nowhere, and his experience as Senior Cattle Manager at the Ponderosa Institute for Bovine Research. Cartwright never published a single research paper, but he was appointed to the editorial boards of five journals. Despite Cartwright's questionable credentials, he was invited to speak at several meetings such as the 5th World Congress on Virology—typically a mark of recognition as an expert. Morgenstern was tired of the constant barrage of solicitations from suspect science journals asking him to join their editorial boards. "At some point I was just so fed up with all those spam emails from these junk publishers that I just did this little experiment," he says. "I contacted them under the fake name Peter Uhnemann and asked to be accepted on the editorial board." Uhnemann was a name borrowed from a German satirical magazine and Morgenstern's first alter ego. Uhnemann immediately joined the masthead of the journal *Molecular Biology*, which belongs to the publishing house OMICS International—which in August was sued for deceptive practices—and is produced "in association" with the Nigerian Society of Biochemistry and Molecular Biology. Unfortunately, Morgenstern admits, he was a bit too subtle: "Hardly anybody knows the name 'Peter Uhnemann,' so I then tried it with a more popular name, and this happened to be Hoss Cartwright." He has also found work for Borat Sagdiyev, the character created by comedian Sacha Baron Cohen. Borat is better known by his first name and less well known as a senior investigator at the University of Kazakhstan, who is still on the editorial board of at least one journal, *Immunology and Vaccines*. That journal belongs to Academician's

Research Center, a publisher based in India that's suspected of "predatory" behavior against scientists desperate to see their work in a journal no matter how obscure or unread (We emailed ARC about its quality control efforts, or lack thereof, but haven't heard back from them). (2)

Cartwright, Uhnemann, Borat, and others are, in some sense, sting operations built to expose the growing practice of gaming the metrics by which scientific publications are judged. The number of publications a scholar has, how many times they have been cited, who the co-authors are—metrics like these should all be secondary to the quality of the work itself, but often they are actually more important. "Scientists no longer publish to share results with their colleagues, but rather to improve their 'metrics,' " laments Morgenstern. These metrics can have real impact on scientists' careers. Edward Calabrese, a toxicologist at the University of Massachusetts, has sat on committees tasked with hiring and promoting faculty, and he sees signs of vulnerability in the process. "Committees are somewhat very self-serving and tend to lower the bar based on personal relationships with colleagues," Calabrese says. "For the most part I doubt that they are very alert to being manipulated and can therefore be easy targets. In most departments I think it is likely that the faculty may not even evaluate the quality of the papers, giving up their judgment to journals, peer review processes, and the letters of external reviewers," he adds. "It is easier to use these means for decision making." And that's in the United States. The Medical Council of India recently updated its guidelines to require publication of four papers to become associate professor, and eight to become a full professor. The policy has triggered fears among some scientists that the quality of

Indian research will fall as people try to pad their resumes with bogus or crummy papers. (3)

The fact is that professional advancement for scientists around the world is becoming more and more challenging in an era of ever-scarcer funding for research and tightening competition for faculty spots. To succeed in the publish-or-perish environment of academia, most scientists hit the lab and play within the rules. Others, though, hatch schemes. The nuclear option is faking data. But the complexity of the modern scientific publishing environment has opened a host of new, more sophisticated approaches: fluffing up resumes with scam appointments to editorial boards, adding nonexistent authors to studies (or real, high-powered co-authors who didn't participate in the research), and even publishing junk journal articles for the sake of publication count. But, one of today's most direct new frauds is incredibly simple: Make up new people. Jesus Angel Lemus is a Spanish veterinary researcher who has lost 13 papers to retraction over concerns about the veracity of his data. That part's not so unusual—even 13 retractions doesn't put Lemus among the top 30 researchers for retractions. What makes Lemus interesting is that he appears to have created a fictional co-author for five of his articles, one "Javier Grande" (big Xavier, whose vague affiliations, ironically enough, made him a big man on campus at the University of Castilla-La Mancha): bulking up author lists is one way to increase the apparent credibility of a study, particularly if they're from a prestigious—or prestigious-sounding—institution. It's less easy to wrap one's mind around what happened to Bruce Speigelman, a cancer biologist at Harvard who noticed a paper with a curious feature.

Although he didn’t recognize any of the authors on the article, the data looked more than a bit familiar. Indeed, they were his findings, which he had presented at meetings and had been in the process of writing up for publication. Speigelman objected to the journal, which agreed to withdraw the paper. The journal discovered that the group of authors appeared to be completely made up—indeed, none had published a scientific paper before—leading the editors to issue the following notice: “The journal has been targeted by a scheme to defraud our editors, reviewers and readers with submission of a manuscript with falsified author and institutional information and therefore wholly unverifiable scientific claims.” Identity fraud in science will likely be as hard to stamp out as it is in other walks of life. What that means, at least for the time being, is that there is a tiny but growing horde of scientists who are figments of someone’s imagination. (4)

Another emerging channel of scientific fraud is to interfere with the process of peer review, through which new scientific work is evaluated by members of the community before it is published. Peer review is touted as a demonstration of the self-critical nature of science. But it is a human system. Everybody involved brings prejudices, misunderstandings and gaps in knowledge, so no one should be surprised that peer review is often biased and inefficient. Even with the best of intentions, how and whether peer review identifies high-quality science is unknown. It is, in short, unscientific. The past 15 years have seen an exciting surge of experimentation with new models of peer review — open, blinded, pre- and post-publication. Online technologies don't give reviewers more time or stamina. A common claim of new journals, whether legitimate or 'predatory' (those that charge fees to publish, but that do not offer standard publishing services), is rapid review and publication. This is a powerful pull for authors, but the detailed attention and mature reflection required for a constructive review takes time. Hyung-In Moon, a medicinal-plant researcher formerly at Dongguk University in South Korea admitted that he had been reviewing his own papers by exploiting the online system that allowed him to recommend reviewers. He simply recommended himself. Sometimes the names he used were made up, and sometimes they were real scientists. In all cases, the email addresses he provided came back to him. Journals have retracted 28 papers in the scandal, and one editor resigned. More recently, the publisher SAGE, based in California, found itself investigating 130 email accounts. It uncovered evidence that its peer-review process had been compromised: Reviews that researchers say take a half-day's work, on average had come back within minutes of being assigned. At the time of this writing, some 350 papers had been retracted for bogus peer review since 2012. (5)

If making up people or corrupting peer review seem too onerous, a scientist can simply publish a paper in a journal nobody reads. The emergence of a new business model in scientific publishing—coupled with the insatiable imperative to publish one's work—has opened the floodgates for such outlets. While typically readers—through universities—paid subscriptions to support publishing, today, a number of publishers charge authors for the privilege, which allows them to make papers freely available to all readers. While most journals using this model are legitimate, a small but growing cohort have lowered their standards in order to publish (and charge). These predatory journals, as University of Colorado librarian Jeffrey Beall has demonstrated, want to appear to be real journals, with rigorous peer review, so that they can collect payments from authors who publish in them. Some scientists are swindled by predatory journals. Others, though, publish in them precisely because they are scarcely read. (6)

Finally, the softest category of metric gaming is citation stuffing. This practice can be applied even to quality science published by legitimate scientists in top-quality journals. Being able to refer to your papers as "highly cited"—an official designation from indexers such as Web of Science —is a big CV booster. Many scientists list their "h-index" (a measure of how many times their work has been cited) prominently on their CV or homepage. Unfortunately, such metrics have become a version of Goodheart's Law: "When a feature of the economy is picked as an indicator of the economy, then it inexorably ceases to function as that indicator because people start to game it." Here's how "citation stuffing" rings work: If I cite you in exchange for citing me, someone—perhaps a reader, perhaps a machine—will pick up on that fairly easily. But if I create a ring of authors, and I agree to cite you, then you agree to cite Professor B, and then she agrees to cite Professor C, and on down the line until Professor Z cites me, it's much more difficult to detect. And then there are journals that ask authors to cite previous papers in their issues, to bulk up their metrics, much of which are based on citations. Every year, Thomson Reuters has delisted a number of journals—a serious punishment—for excessive self-citation. There is a new class of bad behaviour — one that is driven by a related but different pressure: 'impact or perish'. A curious feature of this kind of misconduct is that the work itself—the science reported in the paper—is usually not in question. Those responsible for this kind of post-production misconduct seek to extract value not from the article itself, but from its citations. It is no longer enough for scientists to publish their work. The work must be seen to have an influential shelf life. This drive for impact places the academic paper at the centre of a web of metrics — typically, where it is published and how many times it is cited — and a good score on these metrics becomes a goal that scientists and publishers are willing to cheat for. Collectively, these new practices don't seek to produce articles that are based on fraudulent evidence or claims. Rather, they use fraudulent means enhance the impact of their publications and inflate the importance of those who write them. All metrics of scientific evaluation are bound to be abused. What we see today, however, is not just the gaming of science metrics indicators, but the emergence of a new kind of metrics-enabled fraud, which we can call post-production misconduct. A curious feature of this kind of misconduct is that it does not matter whether the article is ever read by a scientist, only that its citations will be harvested by bots.These scientists want to produce publications that are near invisible, but can give them the kind of curriculum vitae that matches the performance metrics used by their academic institutions. They aim high, but not too high. This means that unlike data fraud and other forms of conventional misconduct, post-production misconduct does not necessarily pollute the scientific record with false results. But it does erode the credibility of the publication system. (7)

It's tempting to laugh off some of these antics, which seem driven by ego and self-interest. But they also underscore a painful truth: unless the evaluation of scientists—and the all-important doling out of funding—can be wrenched away from bean-counting metrics, history is likely to repeat itself. Tomorrow's metrics gamers may come up with some other ruse. Taking time to read and evaluate a selection of a job applicant's papers takes far more time than plugging a bunch of numbers in to a matrix. But it's precisely that output, not metrics, that science is supposed to be about. The agencies that fund grants and committees that hire and promote academic researchers need to get back to doing the hard job of assessing the value and quality of candidates' scientific work rather than leaning on the crutch of overly simplified publication metrics. (8)

Adapted from Nautilus

<u>**Exercise III**</u>.

Find paragraphs, dealing with the following: predatory, gaming, co-authors, laments, toxicologist, vulnerability, colleagues, manipulated, medical, publication

<u>**Exercise IV**</u>.

Fill in the gaps.

1. A new experiment will soon test the study's results in a more ….............................. way.
2. You can …........................... being born at the wrong time, but you can't do anything about it.
3. But they will stop short of calling the …......................... of his testimony into question.
4. Asked about this …......................... tweet, the spokesman Paul Lindsay admitted it was wrong.
5. It's your information stored by the companies you trust that's been …..............................

6. He has an......................... love for being where he is and doing what he is doing now.
7. I would buy from sources that you're sure are.............................., like video game shops.
8. Rosemary Frank earned the …........................... of certified financial divorce specialist.
9. The strong results, which met analyst expectations, …........................ two vital points.
10. Now, could the problem with schools in the UK be that we're …......................... everything?

<u>Exercise V .</u>

Make up sentences of your own with the following word combinations:

to bulk up, to stamp out, to dole out, to be about, to fund grants, to get back to, to come up with, to laugh off , to bulk up , fed up with

<u>Exercise VI</u>.

Match the words to the definitions in the column on the right:

to sting	in a prominent way; "the new car was prominently displayed in the driveway"
stamina	extremely thorough, exhaustive, or accurate
legitimate	allocate (a job or duty)
subtle	underline (something)

to perish	not discovered or known about; un-certain
rigorous	the ability to sustain prolonged physical or mental effort
to assign	hurt or upset (someone)
to underscore	conforming to the law or to rules
obscure	so delicate or precise as to be difficult to analyze or describe
prominently	suffer death, typically in a violent, sudden, or untimely way

Exercise VII.

Summarize the article "Why Fake Data When You Can Fake a Scientist? "

Part 2

Exercise I.

Identify the part of speech the words belong to. retraction, veracity, insatiable, designation , professor, full, policy, quality, competition, academia

Exercise II .

Form adverbs from the following words:

easy (5), external (5), personal (5), constant (5), rapid(5), powerful (5), real (6), official (7), previous (7), part (7), (8), (8), (8), (9), (9), (9)

Exercise III.

Find synonyms to the following words. Translate them into Russian: mature (5), predatory (6), detect (7), extract (7), responsible (7), enhance (7), misconduct (7), means (7), aim (7), painful (8)

Exercise IV.

Find antonyms to the following words. Translate them into Russian: unknown (5), constructive (5), uncover (5), real (6), influential (7), life (7), fraudulent (7), curious (7), invisible (7), false (7)

Exercise V.

Match the words to make word combinations:

curriculum	credentials
bean	papers
questionable	work
Curriculum	counting
postdoctoral	data
good	vitae
scientific	boards
academic	Vitae
fake	excuse
editorial	metrics

SUPPLEMENTARY READING

Principia

Is it possible that, in the new millennium, the mathematical method is no longer fundamental to philosophy?

When René Descartes was 31 years old, in 1627, he began to write a manifesto on the proper methods of philosophising. He chose the title Regulae ad Directionem Ingenii, or Rules for the Direction of the Mind. It is a curious work. Descartes originally intended to present 36 rules divided evenly into three parts, but the manuscript trails off in the middle of the second part. Each rule was to be set forth in one or two sentences followed by a lengthy elaboration. The first rule tells us that ‘The end of study should be to direct the mind to an enunciation of sound and correct judgments on all matters that come before it,’ and the third rule tells us that ‘Our enquiries should be directed, not to what others have thought … but to what we can clearly and perspicuously behold and with certainty deduce.’ Rule four tells us that ‘There is a need of a method for finding out the truth.’

But soon the manuscript takes an unexpectedly mathematical turn. Diagrams and calculations creep in. Rule 19 informs us that proper application of the philosophical method requires us to ‘find out as many magnitudes as we have unknown terms, treated as though they were known’. This will ‘give us as many equations as there are unknowns’. Rule 20 tells us that, ‘having got our equations, we must proceed to carry out such operations as we have neglected, taking care never to multiply where we can divide’. Reading the Rules is like sitting down to read an introduction to philosophy and finding yourself, an hour later, in the midst of an algebra textbook.

The turning point occurs around rule 14. According to Descartes, philosophy is a matter of discovering general truths by finding properties that are shared by disparate objects, in order to understand the features that they have in common. This requires comparing the degrees to which the properties occur. A property that admits degrees is, by definition, amagnitude. And, from the time of the ancient Greeks, mathematics was understood to be neither more nor less than the science of magnitudes. (It was taken to encompass both the study of discrete magnitudes, that is, things that can be counted, as well as the study of continuous magnitudes, which are things that can be represented as lengths.) Philosophy is therefore the study of things that can be represented in mathematical terms, and the philosophical method becomes virtually indistinguishable from the mathematical method.

Similar intimations on the relationship between philosophy and mathematics can be found in antiquity, for example in the Pythagorean dictum that 'all is number'. The Pythagorean discovery that the square root of two is irrational heralded the birth of Western philosophy by uncovering a fundamental limit in one approach to quantifying our experiences and opening the door to a richer conception of measurement and number. The nature of the continuum – the continuous magnitudes that are used to model time and space – have been a source of fruitful interaction between philosophers and mathematicians ever since. Plato held mathematics in great esteem, and argued that, in an ideal state, all citizens, from the guardians to the philosopher kings, would be trained in arithmetic and geometry. In The Republic, his protagonist Socrates maintains that mathematics 'has a very great and elevating effect', and that its abstractions 'draw the mind towards truth, and create the spirit of philosophy'.

Galileo, a contemporary of Descartes, also blurred the distinction between mathematical and philosophical method. An excerpt from his essay 'Il Saggiatore' (1623), or The Assayer, is often cited for advancing a revolutionary mathematisation of physics: Philosophy is written in this grand book – I mean the Universe – which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles and other geometrical figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering around in a dark labyrinth.

In this quotation, it is philosophy that is written in the language of mathematics. It is no mere linguistic coincidence that Isaac Newton's monumental development of calculus and modern physics was titledPhilosophiæ Naturalis Principia Mathematica (1687), that is, Mathematical Principles of Natural Philosophy. The goal of philosophy is to understand the world and our place in it, and to determine the methods that are appropriate to that task. Physics, or natural philosophy, was part of that project, and Descartes, Galileo and Newton – and philosophers before and after – were keenly attentive to the role that mathematics had to play.

Gottfried Leibniz, another towering 17th-century figure in both mathematics and philosophy, was similarly interested in establishing proper method. In 1677 he wrote: The true Method taken in all of its scope is to my mind a thing hitherto quite unknown, and it has not been practised except in mathematics.

Earlier, in his doctoral dissertation of 1666, he had set the goal of developing a symbolic language capable of expressing any rational thought, and a symbolic calculus powerful enough to decide the truth of any such statement. This lofty proposal served as a rallying cry for the field of symbolic logic centuries later. But Leibniz made it clear that application of the method is not limited to mathematics:

If those who have cultivated the other sciences had imitated the mathematicians … we should long since have had a secure Metaphysics, as well as an ethics depending on Metaphysics since the latter includes the sort of knowledge of God and the soul which should rule our life.

Here mathematics grounds not only science, but also ethics, metaphysics and knowledge of God and the soul. The mathematical approaches adopted by Descartes, Galileo, Newton and Leibniz were major philosophical advances, and this helps explain philosophers' longstanding fascination with mathematics: understanding our capacities for mathematical thought is an important part of understanding our capacities to think philosophically.

The philosophy of mathematics reached its heyday in the middle of the 20th century, buoyed by the previous decades' successes in mathematical logic. Logicians had finally begun to make good on Leibniz's promise of a calculus of thought, developing systems of axioms and rules that are expressive enough to account for the vast majority of mathematical argumentation. Among the various mathematical foundations on offer, one known as Zermelo-Fraenkel set theory has proved to be especially robust. It provides natural and effective encodings of ordinary mathematical arguments, supported by basic logical constructs and axioms that describe abstract mathematical entities known as sets. Set theory provides a compelling description of mathematical practice in terms of a small number of fundamental concepts and rules. In the 1930s, the Austrian logician Kurt Gödel proved important results known as the incompleteness theorems, which identify inherent limits to the ability of the axiomatic method to settle all mathematical truths. Via the mathematical modelling of mathematical practice itself, logic therefore gave us a clear account of the nature and extent of mathematical reasoning.

Logic brought philosophical progress on other fronts as well, such as the nature of truth. In the 1930s, the Polish logician Alfred Tarski offered a mathematical analysis of truth, again providing a positive account while at the same time identifying inherent limits to its range of applicability. The 1930s also brought a clear mathematical analysis of the notion of computability. This provided a compelling analysis of the nature of the kinds of algorithmic methods that were sought by the likes of Descartes and Leibniz, while once again uncovering limitations.

These theories were quintessentially mathematical, set forth in the mathematician's style of presenting definitions, theorems and proofs. But they were also motivated and informed by philosophical debate and understood to be worthy of philosophical scrutiny. As in the 17th century, the line between mathematics and philosophy was not sharp, and it was hard to deny that important progress had been made. Both the positive results and the negative, limitative results were valuable: having a clear understanding of what a particular methodological approach can and cannot be expected to achieve serves to focus enquiry and suggest new avenues for research.

The successes were so striking that, for a while, it seemed that every other branch of philosophy wanted to be like the philosophy of mathematics. Philosophers of science imported the logician's vocabulary for talking about mathematical theories, so that a scientific theory was understood to be something like a mathematical theory supplemented by additionalobservation predicates that served to connect them to the empirical world. It was so common for papers in the philosophy of science to begin an analysis with the phrase 'let T be a theory' that the contemporary philosopher Mark Wilson has described this style of philosophy as 'theory T syndrome'.

In a similar way, philosophers of language imported notions of meaning, reference and truth from the logician's study of mathematics. For all the complexity of the subject, the structure of mathematical language is disarmingly simple. There are no modes or tenses, since mathematicians do not typically worry about when seven became an odd number and what the world would have been like had it been even. The truth of a mathematical statement does not rely on historical context or the circumstances of the speaker, and the communicative norms of mathematics are fairly staid, without subtle presuppositions and implicatures. So a promising strategy for linguists and philosophers of language was to start with the modelling of mathematical language, where the mechanics are more easily understood, and then adapt the models to accommodate a broader range of linguistic constructs.

Philosophers of mind meanwhile imported logical scaffolding to the study ofpropositional attitudes. Roughly speaking, if we are able to know something, believe something, doubt something or wish for something, then that thing must be a kind of entity that is available to thought, perhaps via some sort of mental representation. Such representations, as they were treated in the literature, had a lot in common with the symbolic representations used to represent mathematical definitions and assertions.

Philosophical subjects such as these orbited the philosophy of mathematics, drawing heat and light from the logical account of mathematical practice. The successes in the philosophy of mathematics offered striking examples of what philosophy could achieve. But today the subject has lost its lustre, and no longer has the same gravitational pull. What went wrong?

In part, the philosophy of mathematics was a victim of its own success. For a subject traditionally concerned with determining the proper grounds for mathematical knowledge, modern logic offered such a neat account of mathematical proof that there was almost nothing left to do. Except, perhaps, one little thing: if mathematics amounts to deductive reasoning using the axioms and rules of set theory, then to ground the subject all we need to do is to figure out what sort of entities sets are, how we can know things about them, and why that particular kind of knowledge tells us anything useful about the world. Such questions about the nature of abstract objects have therefore been the central focus of the philosophy of mathematics from the middle of the 20th century to the present day.

In other branches of philosophy, where no neat story was available, philosophers had to deal with the inherently messy nature of language, science and thought. This required them to grapple with serious methodological issues. From the 1950s on, philosophers of language engaged with linguists to make sense of the Chomskyean revolution in thinking about the structure of language and human capacities for understanding and generating speech. Philosophers of mind interacted with psychologists and computer scientists to forge cognitive science, the new science of the mind. Philosophers of biology struggled with methodological issues related to evolution and the burgeoning field of genetics, and philosophers of physics worried about the coherence of the fundamental assumptions of quantum mechanics and general relativity. Meanwhile, philosophers of mathematics were chiefly concerned with the question as to whether numbers and other abstract objects really exist.

This fixation was not healthy. It has almost nothing to do with everyday mathematical practice, since mathematicians generally do not harbour doubts whether what they are doing is meaningful and useful – and, regardless, philosophy has had little reassurance to offer in that respect. It turns out that there simply aren't that many interesting things to say about abstract mathematical objects in and of themselves. Insofar as it is possible to provide compelling justification for doing mathematics the way we do, it will not come from making general pronouncements but, rather, undertaking a careful study of the goals and methods of the subject and exploring the extent to which the methods are suited to the goals. When we begin to ask why mathematics looks the way it does and how it provides us with such powerful means of solving problems and explaining scientific phenomena, we find that the story is rich and complex.

The problem is that set-theoretic idealisation idealises too much. Mathematical thought is messy. When we dig beneath the neatly composed surface we find a great buzzing, blooming confusion of ideas, and we have a lot to learn about how mathematics channels these wellsprings of creativity into rigorous scientific discourse. But that requires doing hard work and getting our hands dirty. And so the call of the sirens is pleasant and enticing: mathematics is set theory! Just tell us a really good story about abstract objects, and the secrets of the Universe will be unlocked. This siren song has held the philosophy of mathematics in thrall, leaving it to drift into the rocky shores.

The field's narrow focus on logic suggests another explanation for its decline. Given that the philosophy of mathematics has been closely aligned with logic for the past century or so, one would expect the fortunes of the two subjects to rise and fall in tandem. Over that period, logic has grown into a bona-fide branch of mathematics in its own right, and in 1966 Paul Cohen won a Fields Medal, the most prestigious prize in mathematics, for solving two longstanding open problems in set theory. But there hasn't been another Fields Medal in logic since, and although the subject enjoys some interactions with other branches of mathematics, it has not found its way into the mathematical mainstream.

Many of philosophy's traditional concerns about language, knowledge and thought now find a home in computer science, where the goal is to design systems that emulate these faculties. If the philosopher's goal is to clarify concepts and shore up foundations, and the scientist's goal is to gather data and refine the models, then the computer scientist aims to implement the findings and put them to good use. Ideally, information should flow back and forth, with philosophical understanding informing implementation and practical results, and challenges informing philosophical study. So it makes sense to consider the role that logic has played in computer science as well.

From the mid-1950s, cognitive science and artificial intelligence (AI) were dominated by what the American philosopher of mind John Haugeland dubbed GOFAI – 'good old-fashioned AI' – an approach that relies on symbolic representations and logic-based algorithms to produce intelligent behaviour. A rival approach, with its origins in the 1940s, incorporates neural networks, a computational model whose state is encoded by the activation strength of very large numbers of simple processors connected together like neurons in the brain. The early decades of AI were dominated by the logic-based approach, but in the 1980s researchers demonstrated that neural networks could be trained to recognise patterns and classify images without a manifest algorithm or encoding of features that would explain or justify the decision. This gave rise to the field of machine learning. Improvements to the methods and increased computational power have yielded great success and explosive growth in the past few years. In 2017, a system known as AlphaGo trained itself to play the strategy game Go well enough to sweep the world's highest-ranked Go player in a three-game match. The approach, known as deep learning, is now all the rage.

Logic has also lost ground in other branches of automated reasoning. Logic-based methods have yet to yield substantial success in automating mathematical practice, whereas statistical methods of drawing conclusions, especially those adapted to the analysis of extremely large data sets, are highly prized in industry and finance. Computational approaches to linguistics once involved mapping out the grammatical structure of language and then designing algorithms to parse down utterances to their logical form. These days, however, language processing is generally a matter of statistical methods and machine learning, which underwrite our daily interactions with Siri and Alexa.

In 1994, the electrical engineer and computer scientist Lotfi Zadeh at the University of California, Berkeley used the phrase 'soft computing' to describe such approaches. Whereas mathematics seeks precise and certain answers, obtaining them in real life is often intractable or outright impossible. In such circumstances, what we really want are algorithms that return reasonable approximations to the right answers in an efficient and reliable manner. Real-world models also tend to rely on assumptions that are inherently uncertain and imprecise, and our software needs to handle such uncertainty and imprecision in robust ways.

Many of philosophy's central objects of study – language, cognition, knowledge and inference – are soft in this sense. The structure of language is inherently amorphous. Concepts have fuzzy boundaries. Evidence for a scientific theory is rarely definitive but, rather, supports the hypotheses to varying degrees. If the appropriate scientific models in these domains require soft approaches rather than crisp mathematical descriptions, philosophy should take heed. We need to consider the possibility that, in the new millennium, the mathematical method is no longer fundamental to philosophy.

But the rise of soft methods does not mean the end of logic. Ourconversations with Siri and Alexa, for instance, are never very deep, and it is reasonable to think that more substantial interactions will require more precise representations under the hood. In an article in The New Yorker in 2012, the cognitive scientist Gary Marcus provided the following assessment:

Realistically, deep learning is only part of the larger challenge of building intelligent machines. Such techniques lack ways of representing causal relationships (such as between diseases and their symptoms), and are likely to face challenges in acquiring abstract ideas like 'sibling' or 'identical to'. They have no obvious ways of performing logical inferences, and they are also still a long way from integrating abstract knowledge, such as information about what objects are, what they are for, and how they are typically used.

For some purposes, soft methods are blatantly inappropriate. If you go online to change an airline reservation, the system needs to follow the relevant policies and charge your credit card accordingly, and any imprecision is unwarranted. Computer programs themselves are precise artifacts, and the question as to whether a program meets a design specification is fairly crisp.

Getting the answer right is especially important when that software is used to control an airplane, a nuclear reactor or a missile launch site. Even soft methods sometimes call for an element of hardness. In 2017, the AI expert Manuela Veloso of Carnegie Mellon University in Pittsburgh was quoted in the Communications of the ACM, locating the weakness of contemporary AI systems in the lack of transparency: They need to explain themselves: why did they do this, why did they do that, why did they detect this, why did they recommend that? Accountability is absolutely necessary.

The question, then, is not whether the acquisition of knowledge is inherently hard or soft but, rather, where each sort of knowledge is appropriate, and how the two approaches can be combined. Leslie Valiant, a winner of the celebrated Turing Award in computer science, has observed: A fundamental question for artificial intelligence is to characterise the computational building blocks that are necessary for cognition. A specific challenge is to build on the success of machine learning so as to cover broader issues in intelligence. This requires, in particular, a reconciliation between two contradictory characteristics – the apparent logical nature of reasoning and the statistical nature of learning. Valiant himself has proposed a system of robust logic to achieve such a reconciliation.

What about the role of mathematical thought, beyond logic, in our philosophical understanding? The influence of mathematics on science, which has only increased over time, is telling. Even soft approaches to acquiring knowledge are grounded in mathematics. Statistics is built on a foundation of mathematical probability, and neural networks are mathematical models whose properties are analysed and described in mathematical terms. To be sure, the methods make use of representations that are different from conventional representations of mathematical knowledge. But we use mathematics to make sense of the methods and understand what they do.

Mathematics has been remarkably resilient when it comes to adapting to the needs of the sciences and meeting the conceptual challenges that they generate. The world is uncertain, but mathematics gives us the theory of probability and statistics to cope. Newton solved the problem of calculating the motion of two orbiting bodies, but soon realised that the problem of predicting the motion of three orbiting bodies is computationally intractable. (His contemporary John Machin reported that Newton's 'head never ached but with his study on the Moon'.) In response, the modern theory of dynamical systems provides a language and framework for establishing qualitative properties of such systems even in the face of computational intractability. At the extreme, such systems can exhibitchaotic behaviour, but once again mathematics helps us to understand how and when that happens. Natural and designed artifacts can involve complex networks of interactions, but combinatorial methods in mathematics provide means of analysing and understanding their behaviour.

Mathematics has therefore soldiered on for centuries in the face of intractability, uncertainty, unpredictability and complexity, crafting concepts and methods that extend the boundaries of what we can know with rigour and precision. In the 1930s, the American theologian Reinhold Niebuhr asked God to grant us the serenity to accept the things we cannot change, the courage to change the things we can, and the wisdom to know the difference. But to make sense of the world, what we really need is the serenity to accept the things we cannot understand, courage to analyse the things we can, and wisdom to know the difference. When it comes to assessing our means of acquiring knowledge and straining against the boundaries of intelligibility, we must look to philosophy for guidance.

Great conceptual advances in mathematics are often attributed to fits of brilliance and inspiration, about which there is not much we can say. But some of the credit goes to mathematics itself, for providing modes of thought, cognitive scaffolding and reasoning processes that make the fits of brilliance possible. This is the very method that was held in such high esteem by Descartes and Leibniz, and studying it should be a source of endless fascination. The philosophy of mathematics can help us understand what it is about mathematics that makes it such a powerful and effective means of cognition, and how it expands our capacity to know the world around us. Ultimately, mathematics and the sciences can muddle along without academic philosophy, with insight, guidance and reflection coming from thoughtful practitioners. In contrast, philosophical thought doesn't do anyone much good unless it is applied to something worth thinking about. But the philosophy of mathematics has served us well in the past, and can do so again. We should therefore pin our hopes on the next generation of philosophers, some of whom have begun to find their way back to the questions that really matter, experimenting with new methods of analysis and paying closer attention to mathematical practice. The subject still stands a chance, as long as we remember the reasons we care so much about it.

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