— verifying that someone trying to access funds in a customer's name is the actual customer. This is increasingly done through layers of multiple passwords that must meet rules on length and complexity, making them hard to enter correctly on mobile devices, for example.

Some banks are experimenting with ways to jettison passwords altogether. In 2013, major German banks deployed a system called photoTAN that uses an application downloaded to a phone or desktop computer to ensure that only customers can see e-mailed account information and that hackers cannot send counterfeit e-mails. The system mathematically encodes transaction information into an image that looks to a hacker or any other observer like a meaningless jumble of coloured squares. But when a customer with the application snaps a photo of the image, it is decoded to reveal the transaction information.

A project by Google aims to revamp a system known as CAPTCHA, which distinguishes humans from programs called bots that can be used in various malicious ways, such as harvesting e-mail addresses. The existing CAPTCHA format asks a computer user to retype a line of distorted text to make the distinction, but as artificial intelligence has advanced, the text distortion has increased such that it often defies humans as well as machines. Google's project aims to make this verification process less painful, and even invisible.

In December, Google deployed a system that, according to the company's online-security blog, "considers a user's entire engagement with the CAPTCHA — before, during, and after — to determine whether that user is a human". Google has not specified what that means, but it is believed to involve tracking a person's browser history and spotting distinctively human cues in how the cursor moves to the text box, for instance. In some cases, the program can verify that a user is human without the person even completing the task.

Another effort being spearheaded by Google, along with the file-hosting service Dropbox and the Open Technology Fund in Washington DC — an organization funded by the US government to foster free speech online — aims to improve user experience to make e-mail encryption easier. There are two existing programs, Pretty Good Privacy (PGP) and GNU Privacy Guard (GPG), which are 'open source' and so can be used by anyone to make e-mail completely indecipherable to those who might intercept it. The systems are safe and effective: whistle-blower Edward Snowden specifically chose to leak US National Security Agency documents to documentary film-maker Laura Poitras because she uses encryption software. He knew that he could communicate with her without fear of anyone eavesdropping.

But these systems are difficult to use, so many people do not. That makes it much easier for cybercriminals to entice people to click on links, especially in the increasingly distracting online world. Google and its partners have helped to establish a non-profit online privacy consultancy called Simply Secure, which is now helping developers of such open-source programs to improve the experience for users. If the effort succeeds, the practice of using counterfeit e-mails to lure people into clicking malicious links could become much less prevalent.

But just as in conventional conflicts, the war against hackers is an arms race. "We design new defences, and then hackers and criminals design new ways to penetrate them," Obama said at Stanford. "So we've got to be just as fast and flexible and nimble in constantly evolving our defences." ■

CAREER DEVELOPMENT

Young scientists go for fresh ideas

Analysis of millions of papers finds that junior biomedical researchers tend to work on more innovative topics than their senior colleagues do.

BY EWEN CALLAWAY

Bad news, scientists: there is a good chance that your most cutting-edge work is behind you.

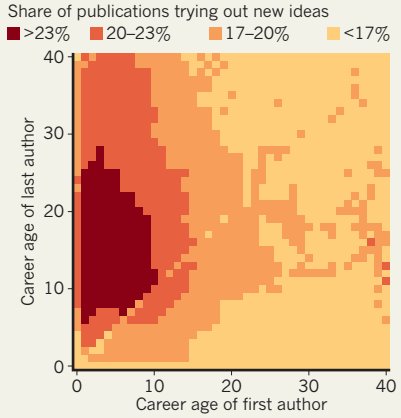
Young researchers are much more likely than older scientists to study exciting innovative topics, according to a text analysis of more than 20 million biomedical papers published over the past 70 years. More-senior researchers are more likely to publish in hot areas when they are supervising a younger scientist.

Researchers are at their most creative when they are young, or so says conventional wisdom: Charles Darwin and Max Planck both argued that young scientists were more open than older colleagues to new ideas. But the topic is not just fodder for chats over post-seminar beers. Funders such as the US National Institutes of Health have implemented policies specifically to support early-career scientists, based in part on the view that young researchers are more innovative than seasoned scientists. And in mathematics, the Fields Medal has been reserved for researchers under 40.

"It's always just a claim — the young are more innovative — but there's no proof," says Mikko Packalen, an economist at the University of Waterloo in Canada, who led the study with economist Jay Bhattacharya of Stanford University in California. Their working paper was published this month by the US National Bureau of Economic Research (M. Packalen and J. Bhattacharya Preprint at http://doi.org/z87; 2015).

HOT SPOT

Pairings of young first authors and mid-career last authors are the most likely to work on the hottest biomedical topics.



SOURCE: M. PACKALEN & J. BHATTACHARYA PREPRINT AT HTTP://DOI.ORG/Z87 (2015)

To determine which scientists used the most innovative ideas, Packalen and Bhattacharya turned to the leading index of biomedical research, MEDLINE (accessed through the website PubMed), which stores more than 21 million articles published since 1946.

The duo developed a computer program that identifies every one-, two- or three-word string in the title and abstract of each paper. It then logs when each string first appeared in the literature and counts how many times it has appeared subsequently, to determine its popularity. (The all-time winning concept was 'polymerase chain reaction', the DNA-copying technique, occurring in more than 176,000 titles or abstracts.)

Packalen and Bhattacharya then ranked the most innovative articles for each year, from 1946 to 2011, on the basis of whether they were an 'early adopter' of the hottest keywords.

The method could not measure researchers' creativity, only their willingness to ▶

embrace new ideas, which might have been proposed by others. But it showed that except for the newest scientists, young researchers far outpaced older scientists in citing new ideas in their papers, Packalen and Bhattacharya found. Because the two had no way of measuring the actual age of a researcher, they calculated 'career ages' — the number of years after a scientist's first publication.

"I really like the way they're approaching things in terms of text analysis," says Bruce Weinberg, an economist at Ohio State University in Columbus, who works with Packalen and Bhattacharya on other projects.

All is not lost for senior scientists, however. Packalen and Bhattacharya also analysed the career stages of papers' first authors (who tend to do the bulk of the research) and last authors (who tend to be supervisors), and found that the most innovative combination was an early-career first author and a mid-career last author (see 'Hot spot'). "One reading of the results is that we quantified something that a lot of people thought was true: that young guys are innovative but they also need some mentorship," says Packalen.

"One reading of the results is that young guys are innovative but they also need some mentorship."

And Weinberg previously found that the age at which scientists make Nobel-prizewinning breakthroughs is increasing (B. F. Jones and B. A. Weinberg *Proc. Natl Acad. Sci USA* **108,** 18910–18914; 2011). "I think we're learning something about what these different measures are picking up," Weinberg says.

Nonetheless, Paul Ginsparg, a physicist at Cornell University in Ithaca, New York, and the founder of the online repository arXiv.org, says that Packalen and Bhattacharya's findings make sense. "In some areas of biomedical research it might take a couple of years to learn a new set of ideas and retool a lab," he says. "Hence it wouldn't be surprising if established researchers have trouble finding the time to do so."

Ginsparg also wonders whether analysing the full text of papers might tell a different story. It could be that established researchers incorporate fresh ideas into an existing methodology and framework, and therefore mention them deeper in a paper.

Packalen, who published his first paper in 2010, knows that the findings could be tough for some older scientists to swallow. "I look at these findings and say, 'No way is this going to happen to me'," he says. "I'm going to stay innovative. I'm going to learn new ideas." ■

LINGUISTICS

Language origin debate rekindled

Eurasian steppe gains ground as Indo–European birthplace.

BY EWEN CALLAWAY

From Icelanders to Sri Lankans, some 3 billion people speak the more than 400 languages and dialects that belong to the Indo-European family. Two fresh studies — one of ancient human DNA, the other a newly constructed genealogical 'tree' of languages — point to the steppes of Ukraine and Russia as the origin of this major language family, rekindling a long-standing debate.

Scholars have long recognized an Indo-European language group that includes Germanic, Slavic and Romance languages as well as classical Sanskrit and other languages of the south Asian subcontinent. Yet the origins of this family of tongues are mired in controversy.

Some researchers hold that an early Indo-European language was spread by Middle Eastern farmers around 8,000–9,500 years ago (see 'Steppe in time'). This 'Anatolian hypothesis' is supported by well-documented migrations into Europe, where agriculturalists replaced or interbred with the existing hunter-gatherers. In 2012, a team led by evolutionary biologist Quentin Atkinson of the University of Auckland in New Zealand produced a family tree of Indo-European tongues that also pointed to an Anatolian origin more than 8,000 years ago.

A competing theory posits that the languages emerged on the Eurasian steppe some 5,000–6,000 years ago, when the domestication of horses and invention of wheeled transport would have allowed herders there to rapidly expand their range. Proponents of the 'steppe hypothesis' note that linguistic reconstructions of a proto-Indo-European tongue include words associated with wheeled vehicles, which were not invented until long after Middle Eastern farmers had reached Europe. "Most linguists have signed up to the steppe hypothesis," says Paul Heggarty, a linguist at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany.

One knock against the theory was a lack of compelling evidence for a large-scale migration from the Eurasian steppe at this time.

A study of ancient human DNA posted to the bioRxiv.org preprint server on 10 February now plugs that gap (W. Haak *et al*. http://doi.org/z9d; 2015). A team led by David Reich, an evolutionary and population geneticist at Harvard Medical School in Boston, Massachusetts, analysed DNA from the bodies of 94 individuals who lived across Europe between 8,000 and 3,000 years ago. The data confirmed the arrival of Middle Eastern farmers in Europe between 8,000 and 7,000 years ago. But they also revealed evidence for a second migration that began several thousand years later. DNA