"It's sometimes a little bit creepy," says Xue. "You show different patterns to the mouse which you cannot see — to you, it's just an empty screen. But the mouse can choose it correctly."

Other groups have also sought to give rodents infrared vision. Eric Thomson, a neuroscientist at Duke University in Durham, North Carolina, developed a system that allowed rats to detect infrared light through four sensors connected directly to the brain (K. Hartmann *et al. J. Neurosci.* **36**, 2406–2424; 2016). But the small number of sensors only provided enough visual information for the rats to find the location of a light, says Thomson. "What is really exciting here is that they actually showed that they got real image information."

Xue says that his technique could have several applications, including giving people "super-vision". Seeing infrared light could help people to see at night, by enabling them to detect infrared wavelengths emitted by, or reflected off, people and objects in the environment. This could be useful for military and security operations, for example.

The team also hopes to adapt the nanoparticles to carry drugs for later release in the eye. But there are several hurdles, including safety concerns, before any use in humans can be tested. For example, the team's nanoparticles contained heavy metals and regulators would be unlikely to approve them for use in humans, Xue says, so the team is developing organic versions.

But not everyone thinks that this technique could be used to augment human vision. The human visual system has evolved over millions of years to be sensitive to a highly specific part of the electromagnetic system, says Glen Jeffery, a visual neuroscientist at University College London, and the retina is not used to seeing infrared. It's uncertain how people would interpret the image: the environment would appear a lot brighter, for example, and the images could be overwhelming.

"I am the last person in the world who would want to see infrared," says Jeffery. ■

PUBLISHING

Paper lets scientists play with each other's results

Online journal eLife *creates paper that lets readers change the code underlying figures.*

BY JEFFREY M. PERKEL

The online journal *eLife* has taken a significant step towards a future in which its papers are much more than just static pages. Readers of the journal's first "computationally reproducible" article can change the code underlying figures to better understand, validate or build on the work. For example, they can rerun the code to see what a figure looks like without outliers, or represented as a different type of plot (see go.nature.com/2c3a9fq).

"What *eLife* is doing is making this commitment to upgrading the research article so that it is not just the written word, but it is this multifaceted communication medium," says Lorena Barba, a mechanical and aerospace engineer and reproducibility specialist at the George Washington University in Washington DC.

The article, which *eLife* first published in its conventional format last year (L. M. Lewis *et al. eLife* **7**, e30274; 2018), is a prototype of technologies the journal now plans to scale up, says Giuliano Maciocci, head of product and user experience at *eLife* in Cambridge, UK. Authors who would like to exploit similar features can contact the journal for consideration, he adds.

In future, such articles could make it easier for researchers to reuse each other's code. Users can't upload their own data and add them to figures, but Maciocci says that the plan is for them eventually to be able to download such articles and run them to, for instance, analyse their own findings using the authors' code. Reusing such software is often surprising difficult, involving confusing sets of interdependent tools, each of which must be downloaded and installed. But *eLife*'s proof-of-concept publication allows users to view and execute code in the body of the article itself, with no installation required.

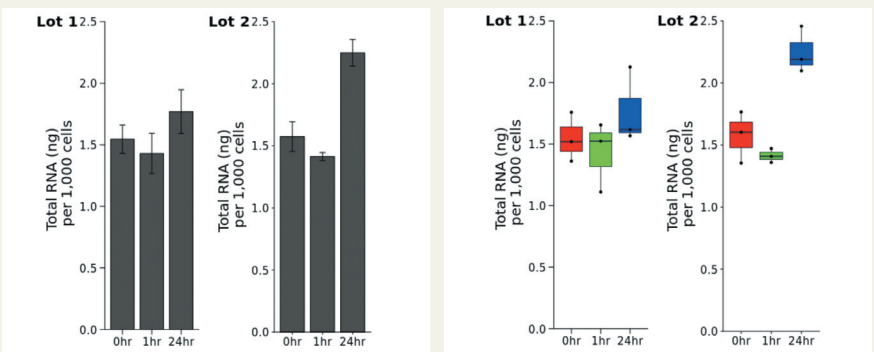
The ability to make reproducible documents is not new, notes Titus Brown, a bioinformatician at the University of California, Davis. Researchers can do it themselves by combining tools such as Jupyter Notebook, an interactive lab notebook, with the cloud-based software Binder that allows others to execute the code. "What's been lacking is the integration with the publisher side of things," says Brown.

Some journals, including *F1000Research*, *GigaScience* and titles from Cell Press, already allow authors to embed executable 'compute capsules' from the cloud-based platform Code Ocean in their articles, with the code and execution environment rendered as an interactive widget. And in August 2018, *Nature Methods*, *Nature Biotechnology* and *Nature Machine Intelligence* launched an ongoing pilot programme with Code Ocean to use the company's compute capsules for peer review. But in the *eLife* article, the code is a native part of the article itself.

The *eLife* paper describes an attempt to replicate a 2012 paper about how a gene that is often mutated in cancer cells impacts the expression of other genes (C. Y. Lin *et al. Cell* **151**, 56–67; 2012). The study was conducted as part of the Reproducibility Project: Cancer Biology, ▶

COMPUTATIONAL REPRODUCIBILITY

Readers of the first computationally reproducible article published by the journal *eLife* can tweak the underlying code to change the figures. In this case, the authors' original figure (left) was altered to change its chart type and coloration.



SOURCE: *ELIFE* HTTPS://GO.NATURE.COM/2C3A9FQ; JEFFREY M. PERKEL

which assesses the reproducibility of findings in oncology and is led by the Center for Open Science in Charlottesville, Virginia, and the Science Exchange in Palo Alto, California.

Created using a collection of open-source tools called the *eLife* Reproducible Document Stack, the reproducible article looks like any other, except that each figure is adorned with a small blue arrow. When the user clicks that icon, the programming code used to produce the figure is revealed in a live, inline text editor. As the user alters the code, the figure updates, allowing the user to adjust the presentation of data (see 'Computational reproducibility') or test the effects of removing outliers.

Casey Greene, a bioinformatician at the University of Pennsylvania's Perelman School of Medicine in Philadelphia, notes, for instance, that the article summarizes some of its data using a bar chart with error bars. It's a configuration sometimes disparagingly referred to as a dynamite plot because of its resemblance to a Wild West-style explosives detonator — and its potential to obscure the underlying data. Using this reproducible article, a reader can recreate that plot in another style to reveal trends more effectively. However, they cannot yet share such a modification with other readers, a feature that Greene would like to see. "That, to me, would be a clear win for this technology," he says.

The article is missing references and supplementary figures, but Maciocci says those will be available in future such articles.

Study author Tim Errington, director of research at the Center for Open Science, says the document represents an evolution of the research article. "The question is, great, now what do we do? How do we keep making this better?" ■

DANIEL LEAL-OLIVAS/AFP/GETTY IMAGES

Nobel-prizewinning biologist Paul Nurse fears UK research will lose money after Brexit.

Q&A Paul Nurse

Brexit: 'UK science is headed for disaster'

As departure day approaches, the director of the Francis Crick Institute says he fears science will drop off the agenda.

For Nobel-prizewinning geneticist Paul Nurse, the gloves are off. Brexit is less than one month away, and Nurse — director of London's Francis Crick Institute — says that UK research is headed for catastrophe.

Most feared is a 'no deal' Brexit scenario, which looms ever closer because the UK Parliament has yet to make an agreement on the terms on which the country will leave the European Union. A deal would allow the United Kingdom to enter a transition period in which many elements of the UK–EU relationship, including valuable EU science funding, would remain largely the same until 2021. But unless the Brexit deadline is extended, the country will crash out of the bloc without a deal on 29 March — immediately affecting trade, immigration and EU research funding.

Although the UK government has guaranteed to replace the money for existing EU grants and successful bids submitted before 2021, details about how this would work are lacking — worrying researchers. UK scientists would no longer be able to host new grants from the European Research Council (ERC), which gives out prestigious, investigator-driven awards.

Nurse spoke to *Nature* about the long- and short-term risks of Brexit for science.

How confident are you that the UK government will be able to implement its research-funding guarantee?

The statements that we hear are relatively reassuring. But the problem is that it's such a shambles that it's difficult to be fully confident and trust what's being said. The science ministers have probably tried their best, but, frankly, it's out of their control as well. I worry that if Brexit happens, then science won't have the influence and profile it will need to be protected, and that we may fall off the end of the agenda.

When does it become unacceptable that scientists don't know what's going to happen on 30 March?

The short answer is that it's unacceptable now. We are in a time of utter chaos. Let's be blunt — there's a complete failure of political leadership in this country, both on the left and on the right. Leaders have sleepwalked the nation into what I think is a big disaster for science. So I have no hesitation in saying that it's unacceptable now.

But it's understandable that we will fall off the agenda because the government has got immense problems to tackle — when the 'Brexiteers' [politicians in favour of Brexit] came out and said it's all going to be simple, they simply hadn't got a clue. So it will continue because it's just so chaotic.

In a no-deal situation, the UK government might create its own version of the European Research Council. What are your thoughts?

A problem I think colleagues worry about is will an ERC replacement be as open-ended in the way the money is allocated as the ERC? The ERC supports quality, investigator-led research, wherever it may be. The question is: will the UK government be as open, or will they, as governments have a tendency to do, meddle and support their particular pet initiatives? Allocating money to particular areas is important, but it's only one end of the science spectrum, and one that always relies on discovery research. If