Comment | Data

Big data needs foundations

Emerging technologies demand action from universities, funders and governments

Mattias Björnmalm is deputy secretary-general of the Cesaer group of universities of science and technology. **Max Lu** is vice-chancellor of the University of Surrey, UK, and chair of the Cesaer/Royal Academy of Engineering taskforce on key technologies

It has become a cliché to call data the new oil but, like many clichés, it has a kernel of truth.

Like crude oil, raw data is of limited value. But when refined and upgraded, data can fuel everything from the frontiers of academic research to businesses across the economy.

Increasingly, data means big datasets that are too large and complex to be dealt with using conventional approaches, and instead require specific tools and approaches for analysis and information extraction. These include data mining and machine learning, which in turn promise to drive advances in areas ranging from personalised medicine and national security to next-generation batteries and solar cells.

But, also like oil, data can lead to corruption and pollution. Data intended to be anonymous, such as patient records, can be intentionally or unintentionally identified with individuals. Data sets with inbuilt biases, in areas such as race and gender, can propagate or even worsen existing prejudice.

And data, like oil, is unstable if treated improperly. The digital infrastructure that underpins the availability, integration and interconnectedness of large-scale data sets was not designed to handle how, increasingly, big data is generated and used, and it often lacks the sustainable funding needed to adapt.

Combined with often outdated legislation, this provides an unstable foundation for developments in the emerging technologies that are expected to profoundly change our societies.

Public assets

To explore how the foundations for big data can be shored up, in 2019 the university association Cesaer and the UK Royal Academy of Engineering formed a joint task force into issues relevant to key technologies such as artificial intelligence, quantum technologies and nanotechnologies. Last month, it published its statement, Key Technologies Shaping the Future: Foresight and strategic recommendations.

The statement lists takeaway messages on the values and leadership needed to develop these technologies fairly and sustainably, and suggests actions for placing big data on more stable foundations aimed at universities, funders and governments.

For university leaders, the task force sets out four recommendations. First is a duty to defend scientific knowledge and technology, including data and digital assets, as public assets. This should involve retaining the rights to scientific findings and outputs, including publications, to prevent siloing and lock-in to commercial platforms. Ensuring effective security and fair value chains for the use of data is also vital.

Second, universities must work to shape the future of the European and global data landscape, including by contributing to the European Open Science Cloud and joining the EOSC Association.

Third, they should ensure professional data support services, for example, by following the rule-of-thumb of employing at least one data steward for every 20 PhD candidates.

Fourth, universities must be at the forefront of projects that use data to improve quality of life, process efficiency and institutional strategy, without compromising privacy and data-safety standards.

For research funders, including national agencies, the first priority must be to provide sustainable funding for the professional support and infrastructures needed for long-term management and stewardship of data and digital assets. They should also support multidisciplinary projects aimed at the grand challenges of the 21st century that use and extract value from data and digital assets.

Governments and policy-makers can help these efforts by creating legal frameworks that reflect the context of public research and education, and protect the generation, sharing and preservation of scientific knowledge and technology.

Legislation should go along with a joint effort by policymakers and the scientific community to develop coherent, clear and internationally aligned strategies to support the professional management and stewardship of data and digital assets. Strategies and policies must be targeted to increase transparency and build trust in the use and deployment of big data. There is already much to build on here, such as the Fair principles, stating that digital assets should be findable, accessible, interoperable and reusable.

Our societies are at a tipping point, facing huge local and global challenges, ranging from pandemics to climate change, along with rapidly emerging and increasingly mature technologies. Complacency is not an option.

The technologies currently emerging are likely to have profound impacts; to guide their development in a positive direction, it is vital that we have a stable foundation to build from.

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Comment | Sustainability

Make being green easier

Academics shouldn’t have to balance working sustainably and career success

Katie Major-Smith is a PhD student at Plymouth Marjon University, UK and a student climate commissioner on the Climate Commission for UK Higher and Further Education

Recently, I was designing a survey of food choices in Bristol, England. To make my study representative of the English city’s population, I had to send paper invitations to randomly selected households. That meant lots of printing, and some guilt—especially as, thanks to my university’s efforts to reduce paper consumption, the printer software kept me updated on how many trees I was using up.

I then decided to add a teabag to the invitations as an incentive to respond (it didn’t work). That led me to look at the environmental commitments of tea companies. And don’t get me started on trying to find envelopes made from certified forests that were within my budget—I nearly cried.

When researchers consider reducing the environmental impacts of our work, we usually think of travel, especially flying. But as I’ve found out, sometimes the challenges are less obvious.

My efforts to minimise environmental impact added a lot of work to that small PhD study. I also found myself having to balance environmental considerations with scientific rigour—an online survey would have used fewer resources, for example, but not yielded a representative sample.

Despite these challenges, I know I’m lucky—I am at a supportive university that encourages open dialogue about environmental issues in research and is committed to becoming more sustainable. Early career researchers at other institutions may not be so fortunate, and it must be even harder for those whose topic is not focused on sustainability.

Researchers know that trying to reduce their environmental impact can hinder their research experience and career progression. If we don’t fly to a conference, we lose the opportunity to share our research and start relationships that could lead to future collaborations or jobs. Instead, someone else is likely to take our place, meaning that the environmental impact of our decision may be small but the professional costs high.

That said, sustainability is becoming more strongly integrated into research practices, thanks to initiatives such as the Laboratory Efficiency Assessment Framework, which certifies sustainable labs. Many universities have committed to reducing their carbon footprint by signing up to the Race to Zero campaign. Journals are also acting: late last year, Research in Engineering Design announced that authors would be required to submit environmental impact disclosures with their papers.

These initiatives take time to establish, but they spark discussion, reflection and enthusiasm among academics about trying to minimise their environmental impact throughout the research process.

Pandemic progress

The pandemic has also taught us a great deal, encouraging researchers to try to embrace new technology. Hybrid conferences that mix online and in-person attendees are becoming the norm, as is working from home. The use of online video platforms for meetings, interviews and engagement with stakeholders is raising new questions about how we conduct research. These practices can be more inclusive, as well as greener.

This progress shows that researchers can change how they work to help address the climate crisis, but greater action still is needed. A truly serious effort to reduce the environmental impact of research will also mean changing research culture.

Measures of success need to shift, with greater weight given to the environmental and social outcomes of research, instead of numbers of publications and journal impact factors. Research also needs to be more transparent. That means more sharing of research materials, more collaboration with low- and middle-income countries, better opportunities to publish our failures, and ensuring that open-access publication is accessible to all, not just those at wealthy institutions. Could that £8,290 (€9,500) to publish open access in Nature be better spent on sustainable research practices?

It should be mandatory for universities to report their greenhouse gas emissions annually, as the student members of the Climate Commission for UK Higher and Further Education have demanded. Openly reporting emissions will help the sector’s carbon footprint become better understood and changes more measurable.

The need to address the climate crisis is more obvious than ever. The discussions on integrating sustainability into the research sector should become broader and louder, spurring the innovative solutions needed to reduce the environmental impact of research.

Research is becoming more sustainable, but progress needs to be bigger and faster. We have the potential—and necessity—to achieve so much more.

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