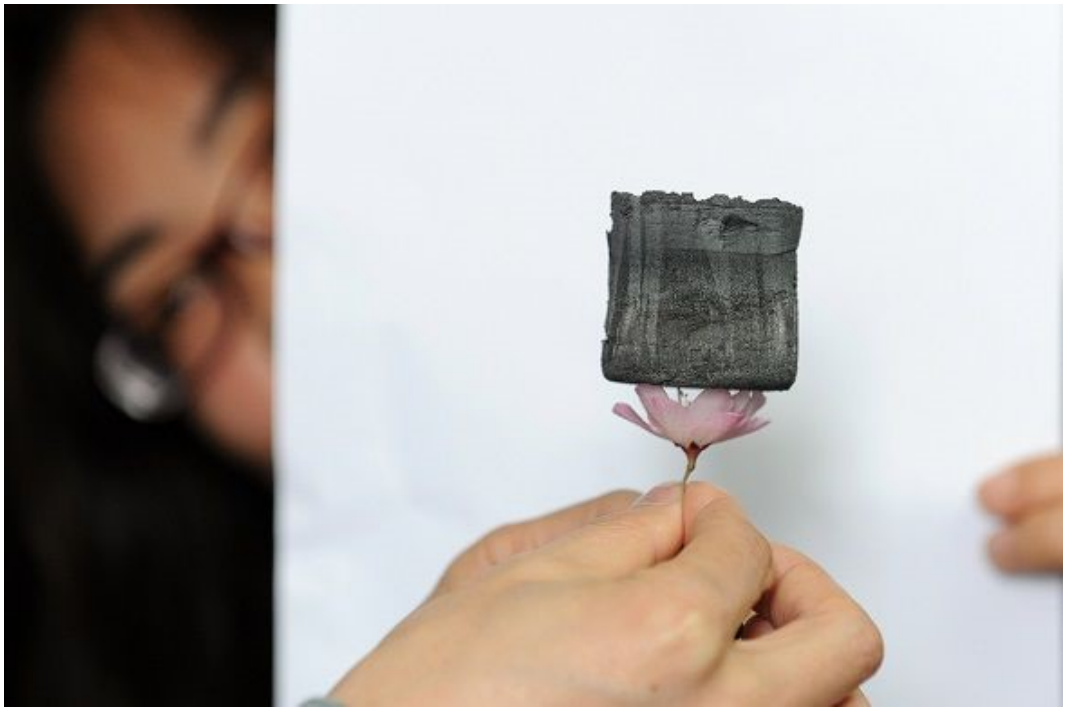
Science and AI: Don’t forget the human factor…

Written by: Anne-Lise Prigent, OECD Observer

Last update: 13 May 2019



ZUMA Press | ©PLANET Pix/ZUMA-REA

Science and AI: Don’t forget the human factor… | Ultra-light graphene aerogel resting on a flower at Zhejiang University, China.

Ever heard of “magic-angle” graphene? This is a next generation material and newly-found superconductor that could revolutionise energy efficiency, and much more. It could help us address climate change. AI could play a key role in this. But real scientists are needed too…

“Chance benefits only the prepared mind” said French scientist Louis Pasteur. Pasteurisation was an unexpected discovery, the realisation that passing air (that is, oxygen) could actually stop the fermentation process. Such discoveries have prevented diseases and saved lives. In short, basic research and chance findings go hand in hand.

Take the example of superconductors. An Oxford student, Thomas Hornigold, described them as one of "the most bizarre and exciting materials yet discovered." Bizarre but not uncommon. Already superconductors conduct electricity with zero resistance, meaning no power loss. This makes them very energy efficient.

But there's a catch: conventional superconductors need to be cooled below a certain temperature (about -270°C) to work. And this requires a lot of energy. Moreover, they are cooled with liquid helium, which is expensive, non-renewable and scarce (in fact, it's running out). This seriously limits the large-scale use of superconductors and the benefits we could draw from them. The ideal, and so far elusive, scenario would be for superconductors not to need cooling by working at room temperature.

Room-temperature superconductors would greatly improve our chances of avoiding irreversible global warming

In fact, room-temperature superconductors would completely transform the way energy is stored, distributed and used on our planet. As Hugh Cartwright, from Oxford University's Physical and Theoretical Chemistry Laboratory points out: "this would greatly improve our chances of avoiding irreversible global warming. It would revolutionise areas such as medicine and industry."

With room-temperature superconductors, we could reach 100% renewable power, for instance. We could also eliminate power loss in energy transmission lines, and do a better job of closing inefficient power lines. Superconductors can also help save helium, in hospital MRI units for instance. Other goals include transport (more efficient engines and so on) by making it greener and safer too. The world's fastest trains already use superconductors thanks to "maglev" (magnetic levitation), which lifts them above their tracks. With room-temperature superconductors, it would be far easier and less expensive to build such greener trains.

But are room-temperature superconductors a realistic prospect? One promising area to explore is a relatively new material called magic-angle graphene, which some people dub the "magic superconductor".

Graphene is a purely carbon-based material, which was discovered by chance as recently as 2004. It is the thinnest material known, is light, flexible and stronger than steel. And it is an even better conductor of electricity than copper.

And there is more… In 2018, physicists at MIT, led by Pablo Jarillo-Herrero, and Harvard University discovered that graphene has two extreme properties: it can be both an insulator and a superconductor. When two layers of graphene are sandwiched together, and then one is rotated by a "magic angle" (about 1.1 degrees), graphene becomes a superconductor unlike any other.

"One reason for the intense interest in twisted graphene is the stark similarities between its behaviour and that of unconventional superconductors. In many of

these, electric current runs without resistance at temperatures well above what the conventional theory of superconductivity generally allows. But quite how that happens remains a mystery.", writes Elizabeth Gibney.

Graphene is still a mystery. The very discovery of magic-angle graphene itself was completely unexpected. It happened almost by accident, but not quite; by accident and sagacity, as can be the case with basic research. Scientists were simply "trying to see how graphene would react when placed at different angles", Colm Goreyexplains.

This is not something a computer could have done. Scientists show creative insight whereas computers, do not (at least not yet) notes Cartwright. Although computers are becoming ubiquitous in science, he points out, "they are helpless at suddenly saying: "Gosh I've had a really cunning thought!" They just don't do that."

More work is needed to see just how "magic" graphene really is, and this is where, many believe, artificial intelligence can step in. As Mr Cartwright stresses, we simply do not have the brain power to understand some of the more complex problems we need to solve. "Along with large materials databases, AI tools that can learn from recent discoveries such as "magic-angle" graphene superconductors are needed", he says.

For this to happen, AI will need much more data–and relevant data at that. In typical machine learning problems, data is fed into the machine-learning system with the hope that the AI will learn from the data. Once that is done, the AI can spot correlations, make predictions about or identify data it has never seen before.

Not just lost in translation

Models developed from machine learning are predictive, but they are not necessarily (or even usually) interpretable, Mr Cartwright points out. We need AI "linkage" tools that help us do that.

We need translation tools, explains Cartwright: when an AI has deduced something that is not related to any existing scientific models (yes, this may happen), scientists will need a "translated" version they can understand. In short, human competencies and insights are needed for AI to work properly.

As computers become more and more integral to science, scientists see more and more of their responsibilities being taken over. This could have consequences. "If computers push people out of science and other domains, creativity, which is an important dimension of human life, will go to waste." Mr Cartwright warns. Worse, it could cause science to slow down, he argues.

Clearly, scientists have a key role to play in working with AI. As Pasteur said, "Chance benefits only the prepared mind." And it will also benefit those who harness the power of AI, one prediction at a time.

References

This article builds on a presentation made by Hugh Cartwright at the OECD-Oslo Met University Workshop on digital technology for science and innovation: https://www.ccnorway.no/oecdoslomet/

Scientific European (2018), Graphene: A Giant Leap Towards room Temperature Superconductors, Scientific European, Vol. 1 Issue 4, https://www.scientificeuropean.co.uk/graphene-a-giant-leap-towards-room-temperature-superconductors

Gibney, Elizabeth (2019), How "magic angle" graphene is stirring up physics, Nature 565, 15-18, https://www.nature.com/articles/d41586-018-07848-2

Butler, Keith T. et al. (2018), Machine learning for molecular and materials science, Nature 559, 547–555, https://www.nature.com/articles/s41586-018-0337-2

Dumé, Belle (2018), "Magic-angle graphene" behaves like a high-temperature superconductor, Physics World, https://physicsworld.com/a/magic-angle-graphene-behaves-like-a-high-temperature-superconductor

Tantillo, Ariana (2016), Room-temp superconductors could be possible https://phys.org/news/2016-09-room-temp-superconductors.html

Gibney, Elizabeth (2018), Surprise graphene discovery could unlock secrets of superconductivity, Nature 555, 151-152 https://www.nature.com/articles/d41586-018-02773-w

Gorey, Colm (2018), When twisted into "magic angle", graphene becomes a superconductor, Siliconrepublic https://www.siliconrepublic.com/machines/magic-angle-graphene-superconductor

Hornigold, Thomas (2018), Why the discovery of room-temperature superconductors would unleash amazing technologies, SingularityHub https://singularityhub.com/2018/05/13/the-search-for-high-temperature-superconductors/#sm.000tqkx2xgtuf5z11fg2euhh2h3ai