How AI could usher in a new age of scientific discovery

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New research from Imperial Business School shows how AI could be used alongside traditional scientific methods to unlock the secrets of life, nature and the universe.

As the prominence and capability of AI (artificial intelligence) has increased, so has AI-related anxiety. While much of this focuses on generative AI and the potential for it to replace human jobs, **the existential fear often extends to all forms of AI**.

However, new research from Imperial Business School, produced with colleagues at IBM and Samsung, has identified the valuable – possibly critical – role AI can play in furthering human understanding about nature, the world and the wider universe.

Specifically, our research shows how we can work with AI and traditional scientific approaches to discover new laws of nature, which are **provable, robust, and consistent with existing laws**. This simultaneously addresses the drawbacks of

the traditional scientific method, as well as a purely data-driven approach.

The traditional scientific method

Since the 17th century, the scientific method has been the key driver for human discovery of the laws of nature. The approach sees researchers create hypotheses using both existing theory and observations, and then test those hypotheses through experiments.

However, the rate at which this method yields discoveries has been steadily dropping, with academics observing a decline in research productivity that suggests **ideas are simply becoming harder to find**.

> AI-Hilbert was able to successfully derive Kepler's Third Law of Planetary Motion and Einstein's Law of Relativistic Time Dilation

Physicist Paul Dirac summarised the issue neatly when he observed that, "in the early days of quantum mechanics a second-rate physicist could do first-rate work, [but] it has since become difficult for a first-rate physicist to do second-rate work."

As Dirac implies, it seems that much of the low-hanging fruit of scientific discovery has now been picked, leaving more challenging, work-intensive problems to be solved. With this in mind, if we do not want to accept the gradual decline of human discovery and innovation, it's clear **a solution is needed**.

Boosting evidence with data

Fortunately, alongside this decline we have also seen rapid technological advances in terms of data processing; researchers estimate that **raw computing power increased at least six orders** of magnitude from 1991 to 2015. This has led to data-driven approaches emerging as viable paths to new scientific discoveries, with AI tools able to be deployed to identify patterns in large datasets.

In their current form, however, these tools often fail to provide formal proofs for discovered relations or hypotheses, and are prone to "hallucinating" incorrect scientific laws that cannot be either proven or disproven. That means new laws of nature discovered in this way are difficult to explain or justify, making it an insufficient substitute for the traditional scientific method.

Much of the low-hanging fruit of scientific discovery has now been picked

Our research addresses this problem, setting out a new approach to scientific discovery that brings together existing theory and data each step of the way. This could be **the first step towards a scalable solution**, as it provides a means of identifying scientific laws from large datasets while providing proof of their consistency with existing theory.

This will allow new discoveries to be made in areas where background theory is limited, and in areas where gathering data is prohibitively expensive.

Testing the data-driven approach

To test our new approach – named **AI-Hilbert**, after the mathematician David Hilbert – we used it to derive some of the most frequently cited laws in scientific literature. AI-Hilbert was able to successfully derive Kepler's Third Law of Planetary Motion and Einstein's Law of Relativistic Time Dilation, among others.

Breaking this down further to check different scenarios, we tested whether AI-Hilbert was able to derive valid scientific laws purely from **complete and consistent background theory**. For this, we used it to derive the Hagen-Poiseuille equation.

We then tested whether it was also capable of deriving laws from **inconsistent background theory**. AI-Hilbert successfully overcame this by employing data to identify the correct theory, highlighting one of the key benefits of the unified approach. We also found that the system is data-efficient, meaning that as more background theory is provided, it requires less data to derive a scientific law.

A new age of discovery

By demonstrating that an AI system can be made capable of rediscovering existing scientific laws afresh, while dealing with contradiction, we show that it is also likely to be capable of identifying new scientific laws in the future. This potentially ushers in a **new AI-driven age of discovery** to rival the golden age of the scientific method.

This highlights a **useful, supportive and non-attritional role for AI** in helping us grow and develop as a species. Only time will tell whether this comes to pass, but by providing the tools and evidence of their potential, we hope that our study brings us

one step closer to unravelling some of the mysteries of the universe.

This article draws on findings from "Evolving scientific discovery by unifying data and background knowledge with AI Hilbert", by Ryan Cory-Wright (Imperial College London), Cristina Cornelio (Samsung AI), and Sanjeeb Dash, Bachir El Khadir and Lior Horesh from the IBM Thomas J. Watson Research Center.

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Ryan Cory-Wright is an assistant professor in the Department of Analytics, Marketing & Operations and is affiliated with the I–X initiative on interdisciplinary AI and machine learning.

His research interests lie at the intersection of optimisation, machine learning, and statistics, and their applications in business analytics and renewable energy.

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