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NEWS RELEASE Green, deep learning



Source: Shutterstock. Finding ways today to distil the knowledge that makes artificial intelligence so valuable will ensure we have a tomorrow where it is available to those who need it most – and at less cost to the environment.

PRETORIA - A single query to ChatGPT uses as much electricity as burning a light bulb for about 20 minutes. Multiply that by the millions of requests that this artificial intelligence (AI) chatbot receives each day, and the environmental impact is ominous.

The <u>Computational Intelligence Research Group</u> (CIRG), led by <u>Dr Anna Bosman</u> of the University of Pretoria's (UP) <u>Department of Computer Science</u>, is searching for ways to reduce the energy consumption of artificial neural networks without sacrificing their performance.

"If we want AI to be sustainable, we must make it compressible," she says.

Artificial neural networks (ANNs) can automatically extract patterns from data through a process called training or machine learning (ML). While 'artificial', ANNs were inspired by the human brain's ability to process information. ML allowed computers to perform tasks such as image recognition, natural language processing and decision-making without being explicitly programmed. However, the size and complexity of the ANNs have grown

exponentially over the past decade, and that's not always good news.

"State-of-the-art ANNs often have billions of parameters, demanding massive computational power for training and deployment," Dr Bosman explains. "This rapid increase in model size has raised significant concerns about their accessibility and environmental impact. The data centres built in Ireland, which are crucial for the modern ML infrastructure, are projected to consume 27% of the country's electricity by 2029. An average data centre is estimated to use as much water as three average-sized hospitals. Using large ANNs is costly and has a significant environmental footprint."

Another downside of large ANNs is that they cannot be deployed in resource-constrained environments. Not everybody has access to a Google data centre. As such, impressive progress in AI remains inaccessible to those who may need it most: doctors in rural areas, small-scale farmers and nature conservationists.

"Energy efficiency can be achieved in two ways: by compressing large models to reduce their size or by designing more expressive ANN architectures requiring fewer parameters to achieve comparable results to standard ANNs," Dr Bosman says.

A promising avenue for green ML is knowledge distillation (KD), a method of transferring knowledge from a large 'teacher' ANN to a smaller 'student' ANN to preserve performance in a more compact form; this is done by mimicking the information representation of the teacher. Using this technique, Dr Anna Bosman and collaborators achieved a tenfold reduction in the size of a pest detection model for a farming project in Rwanda. Another research project is underway where KD methods are applied directly to the ANN parameters rather than the outputs they produce.

Heinrich van Deventer, a PhD student at CIRG and recipient of a Google PhD Fellowship, is using his background in theoretical physics to develop radically new compact ANN architectures (or neural operators) from the ground up. The trick is to treat inputs as continuous functions similar to analogue computing, rather than discrete or independent variables.

"Such compact ANN models may become the building blocks for the next generation of AI that is accessible to all, and mindful of the world," he says.

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This story was originally featured in the <u>Re.Search</u> magazine. Check out <u>Issue 10</u> of the magazine, which details some of our work, from advancing the field of wound care to understanding supermassive black holes.

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ABOUT THE UNIVERSITY OF PRETORIA

The University of Pretoria (UP) is one of the largest contact and residential universities in South Africa, with its

administration offices located on its Hatfield Campus in Pretoria. This 115-year-old institution is also one of the largest producers of research in South Africa.

Spread over seven campuses, it has nine faculties and a business school, the <u>Gordon Institute of Business</u> <u>Science</u> (GIBS). It is the only university in the country with a <u>Faculty of Veterinary Science</u>, which is ranked the best in Africa. UP has 120 academic departments and 92 centres and institutes, accommodating more than 56 000 students and offering about 1 100 study programmes. It has the most academic staff with PhDs (70%), NRF-rated researchers (613).

The 2025 Times Higher Education subject rankings placed UP first in South Africa in the fields of <u>Accounting</u> and <u>Finance</u>; <u>Architecture</u>; <u>Electrical and Electronic Engineering</u>; Law; Sport Science; and Veterinary Science. UP's Faculty of Law has been ranked as the top law school in Africa for a remarkable eighth consecutive year.

Quacquarelli Symonds (QS) ranked the University among the top five in Africa, as part of their <u>2024 World</u> <u>University Rankings (WUR)</u>. UP was the only South African university featured in the <u>2023 World University</u> <u>Rankings for Innovation (WURI)</u>, falling within in the 101-200 range of innovative universities.

For more information, please go to www.up.ac.za