Human-machine interaction enables development of highly accurate decision-making systems

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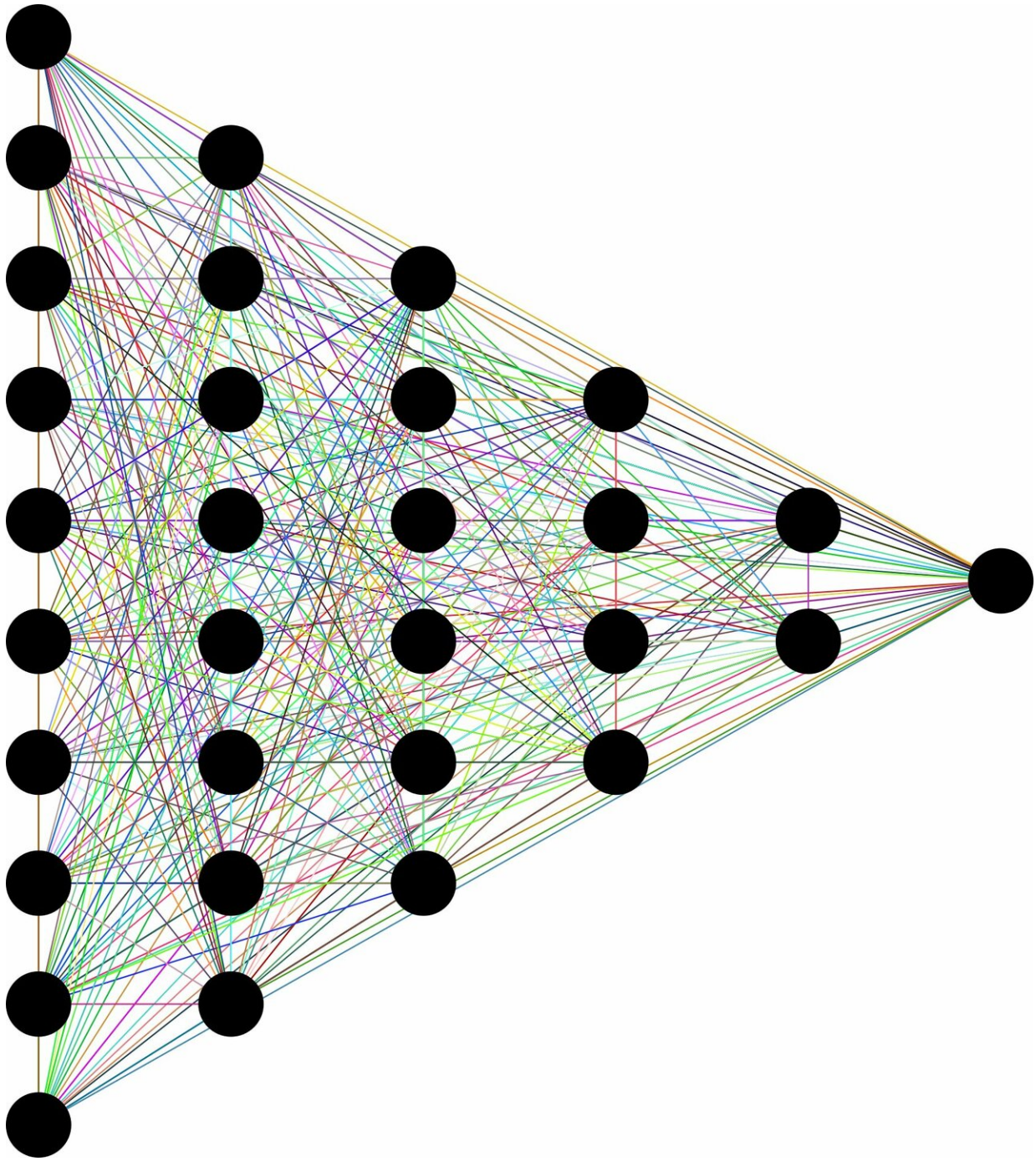

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Machines can be trained to classify images and thus identify tumors in

CT scans, mineral compositions in rocks, or pathologies in optical microscopy analyses. This artificial intelligence technique is known as machine learning and has gained new applications in recent years.

Machine training is carried out via the repetition of images used as examples of a particular context or situation and the adequate preparation of that material requires the effort of experts from a variety of areas.

"The human coordinates [the training]—without a specialist controlling the training process, the machine would learn to make decisions based on characteristics of the image that are not related to the target problem. This generates a poor result or one restricted to the database in which the machine was trained. When the database changes, errors increase considerably, making the machine analysis unreliable," said Alexandre Xavier Falcão, of the Institute of Computing of the University of Campinas (UNICAMP), in a lecture given at FAPESP Week France.

Falcão has been combining computing science and other areas of knowledge based on machine learning projects in a research line that investigates human-machine interaction in decision making.

Automation of parasite detection

One of the projects led by Falcão and presented at FAPESP Week France aims to automate parasite detection in stool analyses. The research was conducted via a partnership between Immunocamp (a Campinas-based company specialized in hospital products) and researchers from the Institutes of Computing and Chemistry of UNICAMP, as well as the School of Medical Sciences of the same university.

The interdisciplinary team has developed a machine capable of

identifying the 15 most prevalent species of parasites that infect humans in Brazil.

The machine learning technique showed more than 90 percent efficiency, which is much higher than the conventional analyses carried out by humans through visual analysis of optical microscopy slides, whose rates vary from 48 percent to 76 percent at most. The machine is also capable of processing 2,000 images in four minutes.

"The idea is not to substitute the work of humans, not least because they need to train the machines to identify more parasite species and confirm the diagnosis of pathogens detected by the machine, but rather to avoid human fatigue and increase the precision of the results," he said.

One of the innovations created by the team from UNICAMP was a system for separating parasites and impurities based on the principle of dissolved air flotation, which enables optical microscopy slides with fewer impurities to be generated.

In the data science part, the machine is able to carry out an automated scan of the slide and detect parasites that appear in images on the computer screen. This was possible using computational techniques that separate the image components to verify and decide if they are related either to impurities or to one of the 15 parasitic species.

"The human-machine interaction has the potential to reduce human effort and increase confidence in the algorithmic decision. Our approach has shown that including the specialist in the training cycle generates reliable decision-making systems based on image analysis."

Reliable decision-making systems

The aim of the methodology is to minimize the effort made by the

specialist in terms of large-scale image observation, seeking the construction of highly accurate decision-making systems.

"The classical approach, which uses prerecorded examples and no human interaction during training, leaves various questions unanswered. They are essential questions, such as how many examples are needed for the machines to learn or how to explain the decisions made by the machine. Our methodology consists of including the specialist in the machine learning cycle so that questions such as these are answered," he said.

Therefore, the strategy used by Falcão's team for building reliable decision-making systems has been to explore complementary abilities. "Humans are superior in knowledge abstraction. Machines do not tire and are better at processing large quantities of data. So, the specialist's effort is minimized by controlling the learning cycle and the machines' decisions become explainable," he said.

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