Search engine for new breakthroughs in physics

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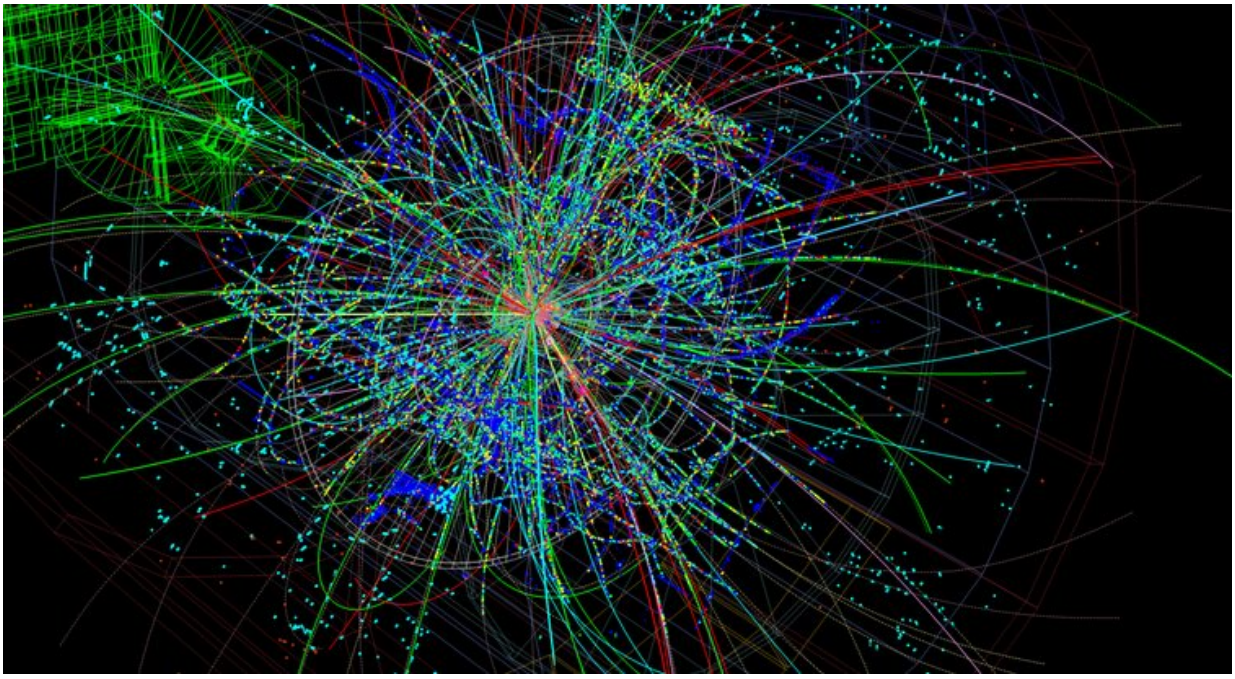

Credit: Radboud University

Imagine that you have a lot of data, but you do not really know what you are looking for. So what do you do? In that case you use a computer that automatically searches for deviations. According to researcher Sascha Caron, this will be a promising method to achieve new breakthroughs in particle physics. Together with other ATLAS researchers at CERN, he has demonstrated this new approach in a paper in The European Physics

Journal C, which was published earlier this month.

Since the discovery of the Higgs Boson in 2012, there were high expectations for new breakthroughs in physics emerging from the Large Hadron Collider (LHC) at CERN. "Unfortunately, there have been few breakthroughs of an equal magnitude, perhaps because we do not search in enough places," says Sascha Caron, physicist at Radboud University and at Nikhef. He is the driving force behind the new method, together with colleagues Sara Alderweireldt and Jeroen Schouwenberg.

Searching for the unknown

At the LHC, scientists produce enormous amounts of data to investigate the standard model for particle physics, which describes the forces and particles that form all matter. Caron: "In the search for the Higgs particle we knew exactly what we were looking for, the only unknown was its mass. Because we currently do not know exactly what we are looking for so we can expand the standard model even further, it takes a lot longer to make to a new discovery. You could compare it with searching for a hidden toy in a large room full of toys, but without knowing what it looks like."

First quickly, then exactly

To speed up the search process, Caron and a number of colleagues have proposed a new systematic approach that can be used to find clues about new particles. Currently, the researchers at CERN look very specifically at a single model or at a single characteristic. According to Caron, this can be done differently: "By using algorithms, we want to investigate all the data simultaneously, using automation, to find deviations from the standard model."

"The disadvantage of this approach is that we can examine the data less precisely than in other approaches," says Caron. To solve this problem, the researchers devised a two-stage method: first quickly compare all data to the standard model, and then focus on the deviations you have found.

AI is the future

Broad search methods with algorithms are already used in other fields, such as genetics. "This broad search method has not been used previously to analyze data from the LHC. This is because the data in particle physics is often very complex compared to data in other fields. If you cannot indicate what kind of data you are looking for, it is difficult to teach an algorithm."

Together with colleagues Sara Alderweireldt and Jeroen Schouwenberg, Caron has recently conducted a second 'run' on the data. He wants to refine the method even more. "My goal is to make discoveries in particle physics through artificial intelligence (AI) and machine learning. A computer is not only objective, automation also provides a cheaper and faster path to scientific progress than the one that is currently being followed – not only in particle physics but in all fields of science."

More information: undefined undefined et al. A strategy for a general search for new phenomena using data-derived signal regions and its application within the ATLAS experiment, *The European Physical Journal C* (2019). DOI: 10.1140/epjc/s10052-019-6540-y

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