NEWS IN FOCUS

CERN

The pixel detector at CERN's CMS experiment records particles that emerge from collisions.

PARTICLE PHYSICS

Physicists turn to AI to cope with CERN collision deluge

Competition with cash rewards seeks better techniques for tracking particle debris.

BY DAVIDE CASTELVECCHI

Physicists at the world's leading atom smasher are calling for help. In the next decade, they plan to produce up to 20 times more particle collisions in the Large Hadron Collider (LHC) than they do now, but current detector systems aren't fit for the coming deluge. So last week, a group of LHC physicists teamed up with computer scientists to launch a competition to spur the development of artificial-intelligence (AI) techniques that can quickly sort through the debris of these collisions. Researchers hope that these methods will help the experiment's ultimate goal of revealing fundamental insights into the laws of nature.

At the LHC at CERN, Europe's particle-physics laboratory near Geneva, Switzerland, two bunches of protons collide head-on inside each of the machine's detectors 40 million times a second. Every proton collision can produce thousands of new particles, which radiate from a collision point at the centre of each cathedral-sized detector. Millions of silicon sensors are arranged in onion-like layers and light up each time a particle crosses them, producing one pixel of information every time. Collisions are recorded only when they produce potentially interesting by-products. When they are, the detector takes a snapshot that might include hundreds of thousands of pixels from the piled-up debris of up to 20 different pairs of protons. (Because particles ▶

move at or close to the speed of light, a detector cannot record a full movie of their motion.)

From this mess, the LHC's computers reconstruct tens of thousands of tracks in real time, before moving on to the next snapshot. "The name of the game is connecting the dots," says Jean-Roch Vlimant, a physicist at the California Institute of Technology in Pasadena who is a member of the collaboration that operates the CMS detector at the LHC.

After future planned upgrades, each snapshot will be expected to include particle debris from 200 proton collisions. Physicists currently use pattern-recognition algorithms to reconstruct the particles' tracks. Although these techniques would be able to work out the paths even after the upgrades, "the problem is, they are too slow", says Cécile Germain, a computer scientist at the University of Paris South in Orsay. Without major investment in new detector technologies, LHC physicists estimate, the collision rates will exceed the current capabilities by at least a factor of ten.

Researchers suspect that machine-learning algorithms could reconstruct the tracks more quickly. To help find the best solution, Vlimant and other LHC physicists teamed up with computer scientists, including Germain, to launch the TrackML challenge. For the next 3 months, data scientists will be able to download 400 gigabytes of simulated particle-collision data — the pixels produced by an idealized detector — and train their algorithms to reconstruct the tracks.

Participants will be evaluated on the accuracy with which they do this. The top three performers will receive cash prizes of US$12,000, $8,000 and $5,000.

PRIZE APPEAL

Such competitions have a long tradition in data science, and many young researchers take part to build up their CVs. "Getting well ranked in challenges is extremely important," says Germain. In a similar competition in 2014, teams competed to 'discover' the Higgs boson in a set of simulated data (the LHC discovered the Higgs, long predicted by theory, in 2012).

TrackML is "incomparably more difficult", says Germain. She thinks the winning technique might end up resembling those used by the program AlphaGo, which made history in 2016 when it beat a human champion at the complex game of Go. In particular, the methods might use reinforcement learning, in which an algorithm learns by trial and error on the basis of 'rewards' that it receives after each attempt.

Vlimant and other physicists are also beginning to consider more untested technologies, such as quantum computing. "It's not clear where we're going," says Vlimant, "but it looks like we have a good path." ■

Grizzly bears in the greater Yellowstone ecosystem could be targeted by hunters as early as September.

ROBBIE GEORGE/NGC/GETTY

CONSERVATION

Hunting proposal might threaten bears

Biologists argue that the plan could endanger grizzlies in iconic ecosystem that includes Yellowstone National Park.

BY GIORGIA GUGLIELMI

On 23 May, Wyoming officials will vote on whether to allow the hunting of up to 24 grizzly bears around Yellowstone National Park this September. The proposal has reignited controversy over whether or not this population has recovered from decades of hunting and habitat destruction — an issue central to the US government's decision to take the bears in the greater Yellowstone ecosystem off the endangered-species list in 2017.

Seventy-three scientists sent a letter to Wyoming Governor Matt Mead on 25 April, asking him to halt the hunt until independent experts can review data on the size of the grizzly (*Ursos arctos horribilis*) population in this area. They are concerned that government tallies overestimate the number of bears in this region, which spans roughly 80,000 square kilometres and is one of the largest continuous wilderness areas in the contiguous United States.

Critics challenge the federal government's methods of assessing whether the grizzly population is large enough to face a hunting season. The estimates might be too high because of several factors, says David Mattson, a wildlife researcher in Livingston, Montana, who retired from the US Geological Survey (USGS) in 2013. These include increased monitoring efforts in the past 30 years and better visibility of bears to aerial surveys because of shifts in where they look for food.

Wildlife scientist Frank van Manen, who leads the USGS Interagency Grizzly Bear Study Team (IGBST) in Bozeman, Montana, disagrees with critics of the government estimates. The IGBST collects population data using a range of methods, including aerial surveys and tagging bears, van Manen says, and the numbers from each method agree. The current population estimate of 718 bears is "extremely conservative", he says.

The Wyoming Game and Fish Department proposed the hunt in February on the basis of those population assessments, and gave the public until 30 April to comment on draft regulations. Under the proposal, hunters could kill up to 12 bears in the monitored region surrounding Yellowstone National Park, and a further 12 bears outside that area (but still in the greater Yellowstone ecosystem).

Mattson and the other researchers who wrote to the governor about the hunt listed several concerns in their letter. Some of the bear's food, such as cutthroat trout (*Oncorhynchus clarkii*), will probably become even scarcer in the future as a result of environmental changes, they say. This would push the animals to hunt livestock or look for food near