Higgs Hunters

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Overview

We are analysing data from proton collisions at CERN in the hope of discovering a new particle, called the baby Higgs. In order to do this, we are using ‘click data’ from a citizen science project to identify collisions of interest, and then exploring the related images in more detail.

Aims

- Identify common errors/patterns in the click data
- Use the data comparisons/observations to refine a computer algorithm that could analyse the data much faster.
- Discover a theorised particle!

Background information

At CERN in Geneva, Switzerland, the Large Hadron Collider (LHC) accelerates beams of protons to over 99% speed of light. These beams are then collided in four detectors, where there their energy is converted to mass. The particles that are created can be classified using the standard model (figure 1). This shows the fundamental particles - i.e. particles that cannot be broken down any further.

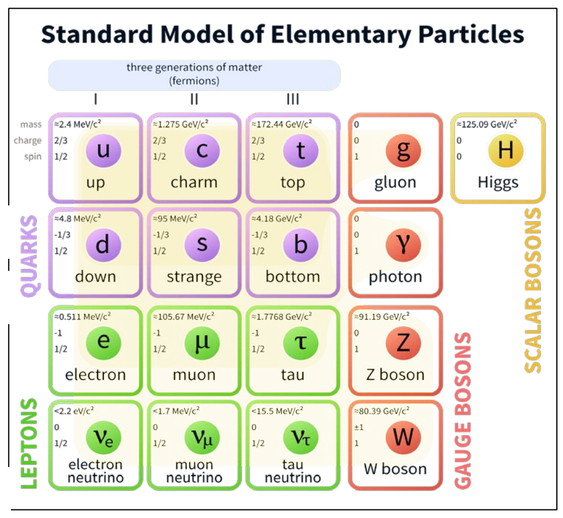

Figure 1: The Standard Model of Particles

In 2012, scientists working at the ATLAS and CMS detectors at CERN announced the discovery of a new particle consistent with the Higgs boson. The Higgs boson is a force carrier that enforces the Higgs field, giving all particles mass. As particles pass through the Higgs field, they are slowed by different amounts determining how much mass they have. For example, photons (the force carrier for the electromagnetic force) interact with the field minimally and therefore are massless, but a top quark interacts with the field greatly and therefore has a large mass. The Higgs boson particle itself has a very short lifetime, decaying quickly into other particles that can be detected. One possibility is that it may decay into an undiscovered particle, which has been nicknamed ‘the baby Higgs’.

Methodology

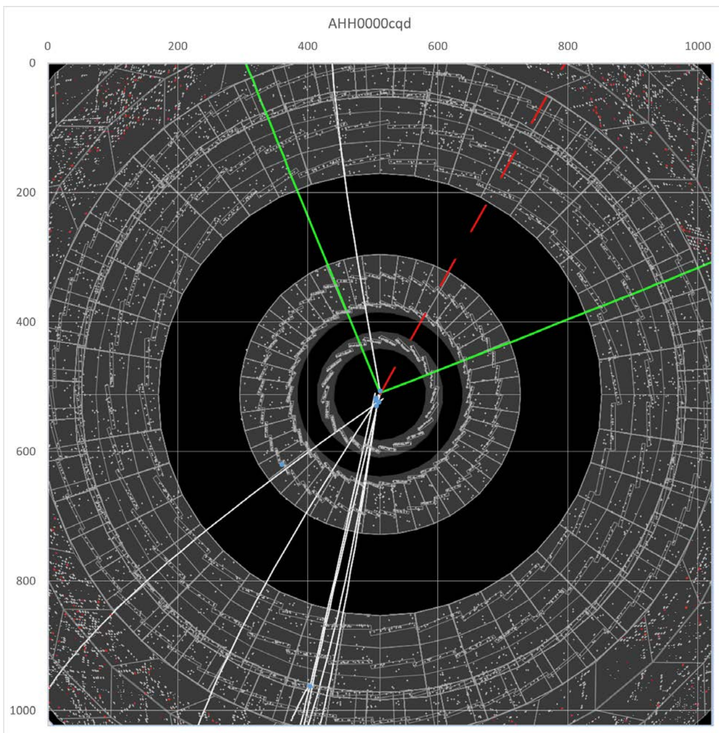

Figure 2: Simulation of a Higgs decaying to two baby Higgs particles with overlaid click data in blue.

In order to identify whether a baby Higgs particle was created, images of the collisions in ATLAS were uploaded to a citizen science website. In these images, the coloured lines show the paths of charged particles travelling away from a collision centre.

People using the website were asked to click on any visual anomalies, including any off-centre vertices. The website proved so popular in fact that over a million clicks were recorded.

Our task now is to sift through all the ‘click’ data and investigate whether any of the tracks provide evidence for the Baby Higgs Particle. To do this, we plot the coordinates of each click on a scatter graph using Microsoft Excel and then overlay the graph onto the original image (figure 2). This allows us to see how well the clicks line-up with the paths and whether any images warrant further investigation.

Conclusion

We have now perfected our technique at processing the ‘click data’ and overlaying it with the images of the collisions.

Evaluation

Now that the real data has been released, we will use the ‘click data’ to identify images worth exploring in greater detail. We will also compare the clicks of different users and attempt to find patterns that could be used to aid in developing a computer algorithm to do this work more rapidly.

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