Muon Hunter: A Zooniverse Project

Michael Daniel
michael.daniel@cfa.harvard.edu
for the Muon Hunter team: Ralph Bird, Hugh Dickinson, Qi Feng, Lucy Fortson, Amy Furniss, Johanna Jarvis, Reshmi Mukherjee, Rene Ong, Iftach Sadeh, David Williams and 5,000+ citizen science volunteers

Help astronomers to find elusive muons disguised as gamma rays!
What is the Zooniverse?
The world’s largest and most powerful platform for people-powered research

At the Zooniverse, anyone can be a researcher
You don’t need any specialised background, training, or expertise to participate.

Volunteers and professionals make real discoveries together
Zooniverse projects are constructed with the aim of converting volunteers’ efforts into measurable results. They have produced a large number of published research papers, open source data sets and even scientifically significant discoveries.

http://www.zooniverse.org/about

Ten years since Galaxy Zoo launched, now 100+ projects
Citizen Science Muon Ring Finder

Goal: Train machines to classify events and identify muon images for
• background rejection
• calibration events

Instead of solely using simulations or hard coded search algorithms we explore the power of people to get a good clean set of muon ring images for the training.

http://muonhunters.org/
Start: a random VERITAS image

Can you see a muon ring in this image?

Yes

Draw a circle that is your best guess at a muon ring

Additional questions about the ring:
- Is the ring you drew completely in the camera?
- Is the ring complete?
- Is the part of the ring in the camera complete?

Done: a muon

No

Done: not a muon

Retire an image when classified 15 times
Launch date: 28th February

In the first week:
- 1 million classifications
- Test phase
Amazon Web Services outage causes widespread internet problems

Last Updated Feb 28, 2017 6:03 PM EST

NEW YORK -- Amazon’s cloud-computing service, Amazon Web Services, experienced an outage in its eastern U.S. region Tuesday afternoon, causing unprecedented and widespread problems for thousands of websites and apps.

Amazon is the largest provider of cloud computing services in the U.S. Beginning around midday Tuesday on the East Coast, one region of its “S3” service based in Virginia began to experience what Amazon, on its service site, called “increased error rates.”

In a statement, Amazon said as of 4 p.m. E.T. it was still experiencing “high error rates” that were “impacting various AWS services.”

“We are working hard at repairing S3, believe we understand root cause, and are working on implementing what we believe will remediate the issue,” the company said.

But less than an hour later, an update offered good news: “As of 1:49 PM PST, we...”

Some affected websites had fun with the crash, treating it like a snow day:

In a twist of irony, the website Down Detector, which tracks web outages across the internet, was itself crippled by the outage:
Also recruit/engage volunteers with social media presence

Facebook

Wordpress blog

Twitter feed
Even a postcard to hand out, e.g. school science fairs, FLWO visitor centre, etc

http://www.muonhunter.org/

Muon Hunter: a Zooniverse project

Astronomers using the VERITAS telescopes to detect some of the highest-energy photons in the Universe need your help!

Gamma-rays originate in astrophysical environments like supernova explosion blast waves, or jets streaming from active galaxies at close to light speed. Muons (a particle like an electron, only heavier!) are a prominent background contaminant when observing these gamma-rays on Earth. They leave a distinctive ring-like shape making them obvious to the human eye, but incomplete or truncated rings can appear very gamma-ray-like to automatic analysis algorithms. We need your help to identify camera images that contain muon rings so we can teach computers to better identify such images and efficiently filter out those pesky muons that are masquerading as gamma rays.
People Reached

The number of people your post was served to in the past 28 days.

Country | People Reached | City | People Reached | Language | People Reached
---|---|---|---|---|---
Venezuela | 3,831 | Caracas, Portuguesa | 645 | Spanish | 3,912
Brazil | 1,557 | Maracaibo, Zulia | 217 | English (US) | 1,914
Mexico | 869 | Mexico City, Distrito Federal | 211 | Portuguese (Brazil) | 1,486
Philippines | 821 | Barquisimeto, Lara | 188 | Spanish (Spain) | 1,408
Indonesia | 623 | Valencia, Carabobo | 175 | English (UK) | 782
India | 574 | Maracay, Aragua | 141 | Indonesian | 604
People Engaged
TAUP 2017 - Muon Hunter
Muon Hunter Talk

Search or enter a #tag

Notes
General comment threads about individual subjects
qfeng RESEARCHER RESEARCHER TEAM Subject 6399579 a month ago

Announcements
Announcements from the Muon Hunter team
Pete Hermes MODERATOR We are currently out of data 3 months ago

Unusual Images
A dedicated board for the discussion of unusual and anomalous images.
Pete Hermes MODERATOR Getting already seen 3 months ago

FAQ
Frequently Asked Questions
mldaniel RESEARCHER RESEARCHER Why do some rings look slightly elliptical? 4 months ago

Recent Comments
Popular Tags:
- truncated
- muon
- partial
- background-shower-plus-muon-ring
- truncated_muon_ring
- muon
- incomplete
- muon-ring
- complete
- iffy
- muon_ring
- backgroundshower
- unusual
- complete-muon
- gamma
- partial_ring
- toughie
- partial_muon_ring
Talk Stats

Current date range: Feb-26-2017 to Apr-30-2017
million muons to pass through every minute.

Each image is about a 20ns exposure, which means we expect about 0.02 muons every ns to be the average rate. The probability of seeing 1, 2, or 3, etc muons is described by something called a Poisson distribution which relates the average rate of an event to the likelihood of seeing it. If 97.7% of the time we see no muons, 2.2% we see 1 muon, 0.02% of the time we see 2 muons, 0.00002% (or only 1 in 5,000) times we see three muons and so on.

In reality that is an oversimplification because the arrival rate of muons is not completely random: the cosmic rays arrive randomly, the air showers they then create contain many thousands of muons arriving just a few nanoseconds apart (and not minutes) spread over an area of a few thousand square metres. Also other particles will create similar rings, e.g. when a muon decays it creates an electron which will produce a similar ring to its parent muon and you will see both rings in the image just slightly separated.

But the general conclusion still holds: most images will contain no muons, a good many will contain one muon, a very few will contain two, and it becomes increasingly rarer still to see any more than that in the same image. We have many hundreds of thousands of images in our dataset so even some rare events have a chance of turning up, such as here.

March 28th 2017, 12:06 am

I am so glad to have seen someone use the Poisson distribution, @mkdaniel! I thought I'd never see it again after college!

Glad I didn't have to sort 5000 images to see one, though. Thanks @HuskyNator for flagging this!
~1 month after launch

VERITAS collaboration O(100) members
The median number of image classifications per volunteer is 30

Gini co-efficient = 0.83

Most have less time to commit, but contribute what they can. A few have a lot of time/interest to devote.

https://muonhunterblog.wordpress.com/2017/05/24/a-quick-look-at-the-volunteer-input/
Of 134,000 images:
12% unanimous votes a ring present
73% unanimous ring not present
15% split votes

Treating all images with $\geq 9/15$ votes for ring as muon events
trained a convolutional neural network model with score of 0.97
of previous algorithm score of 0.95
Summary

• Citizen science is a great resource for both outreach and practical science.

• People are willing (& able) to look through a mountain of data in the search for circles
  ➤ Having a simple, clearly defined project task helped a lot with the success of the project.

• They are also likely to find other interesting things when parsing that much data
  ➤ Feeds into what projects to do next…