Solving (some) of the (virtual) galactic mysteries (sometimes) successfully with Python

A short talk focusing on Python's versatility

Elite: Dangerous

- PvP and PvE MMOish Space Sim
- Continuation of the original 1984 Elite
- PC, Xbox One, PS4
- 1:1 accurately simulated, procedurally generated galaxy
- Typically seen as having the good of both Star Citizen and No Man's Sky without the bad of either
- You can do anything in this galaxy bounty hunt, trade, fight, explore, race, save stranded pilots, even do science!





// TODO: Insert trailer

Let me tell you a story about science

- CMDR Arcanonn intercepts a federal convoy
- Using his manifest scanner, the transport ship was carrying a never seen before item:
 - An UNKNOWN ARTIFACT
- Using a special tool, he engaged the convoy, risking his life and money to acquire the item
- In the end he got away with the precious cargo



The Unknown Artefact

- A mysterious item introduced by the developers
- It would scan you ship
- Then it would beep an audible code
- Then it would rotate and point towards a specific system within the Pleiades Sector:
 - Merope!
- This mystery leads to the birth of the Canonn Institute

Canonn Science and Research

- A fully player run group
- United for one aim: to solve the mysteries of the galaxy
- https://canonn.science
- One of their divisions is the R&D division, dedicated solely to creating tools to help players do science
 - (that's where I help out and the Python is)



Lets fast forward a bit

- The developers are introducing mysteries for players to solve
- They served as a soft re-introduction of the main villain in the original game:
 - The Thargoids!





Closer to present

- A CMDR discovers a guarded unregistered beacon
- After fighting off the very aggressive guard, s/he transcribes the code
- This code lead researchers to a specific system
- This prompted a system wide search of all the planets, which led to a very troubling discovery:
 - An unknown site!









The Unknown Link

- Placing three items in the unknown structure's device:
 - An Unknown Artefact
 - An Unknown Probe
 - An Unknown Link
- Causes the star map to appear and the device to emit an encoded message

The Unknown Structure's Message



Finally some Python!

- A distance from a point in 3D space gives you a family of points which form a sphere
- Three distances means three spheres. We don't know which distance is related to Merope, Col or your current system
- This means that there are 3! = 6 possible combinations.
- Using a trilateration, we can find out of those three combinations, the points where the three spheres intersect

Math is hard

- So I just copied the first working version I found on stackoverflow
- <u>https://stackoverflow.com/questions/1406375/finding-intersection-points-between-3-spheres/1406415</u>

```
https://stackoverflow.com/questions/1406375/finding-intersection-points-between-3-spheres/1406415
def trilaterate(P1, P2, P3, r1, r2, r3):
   r1 *= thargmeter constant
   r2 *= thargmeter constant
   r3 *= thargmeter constant
   temp1 = P2-P1
   e x = temp1/norm(temp1)
   temp2 = P3-P1
   i = dot(e_x, temp2)
   temp3 = temp2 - i*e x
   e_y = temp3/norm(temp3)
   e_z = cross(e_x, e_y)
   d = norm(P2-P1)
   j = dot(e_y, temp2)
   x = (r1*r1 - r2*r2 + d*d) / (2*d)
   y = (r1*r1 - r3*r3 - 2*i*x + i*i + j*j) / (2*j)
   temp4 = r1*r1 - x*x - y*y
   if temp4<0:
   z = sqrt(temp4)
   p_12_a = P1 + x*e_x + y*e_y + z*e_z
   p_{12}b = P1 + x*e_x + y*e_y - z*e_z
   return p 12 a, p 12 b
if name == ' main ':
   center merope = numpy.array([-78.59375, -149.625, -340.53125])
   center col70 = numpy.array([687.0625, -362.53125, -697.0625])
   center origin = numpy.array([-64.40625, -269.5625, -373.59375])
   distances = [0.151 * thargmeter_constant, 0.937 * thargmeter_constant, 0.01 * thargmeter constant]
   answer = trilaterate(center merope, center col70, center origin, distances[0], distances[1], distances[2])
 🍚 print(answer[1])
```

But how will we know if there are systems?

• MORE ELITE: DANGEROUS TOOLS!

Only Populated Systems	Allegiance	Governme	ent	Primary Economy				
Yes	Select Allegiance	 Select A 	Allegiance •	Select Economy *				
Minor Faction				Presence Type				
Search for a minor faction			¥	Presence or Control? •				
Needs Permit	Station Filter	Powers		Power Effects				
Yes or No	Having stations?	Add Pov	wers	Add Power Effects				
Reference System		State		Security				
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First Method

- Get the three ratios
- Generate the six possible permutations
- Multiply them by the THARGMETER (distance from Merope to Col 70)
- Trilaterate the combinations
- For any intersection points (the result is X, Y, Z): ping EDSM's API
- Turns out, EDSM's API does not have a "closest system to these coordinates API call"

Second Method

Download the system data dump from EDDB (they don't provide an API)

root@charitybot:/home/data# wc -l systems.csv 11659335 systems.csv root@charitybot:/home/data# ls -l -h systems.csv -rw-r--r-- 1 root root 1.4G Jul 22 11:33 systems.csv root@charitybot:/home/data#

- That's a lot of data...
- Compare the resultant co-ordinates with the co-ordinates of every single system
- One system per row, that means 11659335 systems!
- (FYI, E:D galaxy is 400 billion stars large)

The Results

- Using flask (not 会会Django会会)
- Using basic HTML form to input co-ordinates then run the script
- Of course it took far too long to run the script before the HTTP request timed out...
- I could have run it asynchronously, using celery, but...
- It didn't work!
- https://github.com/purrcat259/thargoid-searchtools/tree/master/possible-new-sites

For three days, it was a frenzy

- New sites being discovered within minutes of each other
- R&D felt the need to visualise the discoveries
- They already had a 3D map of the galaxy written in JS
- <u>https://github.com/canonn-science/USGalMap</u>
- But they had no data for the Unknown Structures

Python to the rescue again!

- What we had:
 - A lot of data on Systems (~1.2GB)
 - A LOT of data on Stellar Bodies (~9.6GB)
 - A list of systems + planets where Unknown Structures were present
- What we wanted:
 - Planet data about each planet where a structure was discovered
 - Temperature, Axial Tilt, Solar masses, etc

The method

- Take the list of Planets (provided to me in a text file)
- Parse the systems file to get the ID of the systems
- Parse the bodies file, matching the ID of the system to get the bodies in that system
- Get the data for that body if it is present
- Output it in a JSON file
- Make it available as an API over the internet using Flask
- https://github.com/purrcat259/thargoid-searchtools/tree/master/unknown-sites-body-data

Profit!! https://map.canonn.technology/us/



That's all 😳

• Any questions?