A study into target selection in the Thargoid attacks of 3305

By factabulous and Redden Alt-Mer
Sponsored by the Canonn Interstellar Research Group

Abstract

The Eagle Eye targets in 3305 have been studied and it was found that they are based on per-installation parameters, so that Eagle Eye 1 targets have one set of parameters, Eagle Eye 2 targets follow a different set of parameters &c. These all follow a pattern of looking for certain resources within the systems that are targeted.

These are summarised below - targets from the different Eagles will each match one or more of these attributes:

Eagle Eye	System Economy	Planet Types	Atmosphere Types
1	Industrial / Military		
2	Military / Terraforming		
3	Industrial / Military		
4		Ammonia World	Ammonia-rich
5	Military / High Tech		
6	Agriculture / High Tech		

Table 1: Systems Attributes matching different Eagle Eye Installation

This is a change from previous targeting, where the Thargoids appeared to be targeting only systems with Ammonia (similar to Eagle Eye 4). Looking at the targets for each Eagle Eye installation it appears that they normally are spaced less than 40 Ly apart, and seem to be clustered in particular areas (though both these parameters are inconsistently applied).

It is hoped that further research can allow us to determine the Eagle Eye targets independent of the Eagle Eye network - there has already been a proof of concept for this as CD-54 471 was identified by Redden when a partial update happened in the Eagle Eye network. Further work will be required to reduce the search space further in these instances.

Introduction

The Eagle Eye network is used by the Aegis organisation to monitor and track the Thargoid attacks that are currently taking place in the human ‘Bubble’ and the Pleiades. It consists of 6 installations, in the Pleiades, which transmit an encoded system name at known intervals. Each of these systems is known to locate a system where Thargoids are amassing. In the past (3303-3304) these systems have been:

- Attack targets
- Previously Attacked installations / megaships
- Thargoid Structures
- Barnacles

In 3305 the targets started to be a mixture of attacked systems (so called Thargoid Incursions) and systems with no known Thargoid presence. These were found to be what we call ‘Thargoid Infestations’ - systems that start to have Non Human Signal Sources appear soon after they are targeted. If a sufficient number of Thargoids are removed from the system then the system can be cleared of the Thargoid presence, otherwise a system Starport can be attacked, and the system itself go into Thargoid Incursion.

In 3303 and 3304 the targets detected by Eagle Eye tended to have an Ammonia resource (either an Ammonia World, Gas Giant with ammonia-based life), and to have a Starport with Large Landing Pads.

In 3305 (actually from mid-December 3304) these targets started follow a different pattern, not always being Ammonia related and not always having a Starport. Initial work by Redden Alt-Mer that found that while the complete set of targets did not follow the previous pattern those from Eagle Eye 4 were still Ammonia related. Redden also found that Eagle Eye 6 was targeting systems with at least one Agricultural stations (and Water Worlds or Earth Like Worlds). Data was gathered from the Eagle Eye targets was gathered and automated analyses were performed to attempt to detect the patterns with the help of factabulous.

In this paper we will go through a description of the Eagle Eye system we are trying to predict, the target data we have, and the results as they stand.

Target Selection

Targets from Eagle Eye present a challenge as:

- We don’t always know if a target was real. Especially early Infestations, which were beaten and so did not cause an Incursion, we don’t know if the target *would* have led to an Incursion
- Sometimes the Aegis network has been found to update multiple times in a week. In these cases we cannot be sure if the first or second (or both) sets targets are the intended targets.

- Some targets do not get attacked, so it is not clear if they were real targets, or decoys (in 3304 it was common for decoy targets to be uses, these were found via the use of Thargoid Links)
- Some targets are in the Pleiades. These are often not attacked, but this could be due to the strong defense put up by Operation IDA et al. Another issue with the Pleiades targets is that they break the limits we have for jump distances between targets. This problem applies to Eagle Eye 1-3, as only these have targets in the Pleiades.
- Some weeks we have less than six targets - Eagle Eyes 1-3 are duplicates in Eagle Eyes 4-6. This means for these weeks we do not know which dataset these targets belong with.

To account for these issues two approaches were taken:

- Redden's calculations were based on a subset of data taken from later weeks, as from this point there were no Pleiades targets and the data can be considered 'as is'
- factabulous used the complete set of targets, but classified the targets as either Mandatory or Optional. Optional targets may be checked for compliance to a found relationship, but if they do not match they will not cause the relation to be discarded. Targets such as those in the Pleiades were flagged as Optional. This leads to a larger dataset, but adds the possibility of experimenter bias in assignation of the Optional flag.

Update #	Date	EE1	EE2	EE3	EE4	EE5	EE6
0	20/12/2018	Maia	Merope	Kupol Vuh	Jormbu	Wuli	Werapana
1	10/1/2019	pleiades sector hr w d1 41	pleiades sector hr w d1 42	hr 1172	hip 2843	madrus	bhagutsuk
2	17/1/2019	celaeno	pleione	atlas	hip 117960	nian	ross 596
2'	18/1/2019	kekenk	muracing	hip 21167	kekenk	muracing	hip 21167
3	24/1/2019	Xeno 55	Xeno 55	Xeno 55	Xeno 55	Xeno 55	Xeno 55
4	31/1/2019	asterope	merope	sterope II	hip 9141	bolg	hip 21167
5	7/2/2019	palanti	ariatia	Pleiades Sector KC-V c2-4	Kareco	CE Bootis	hip 23395
5'	14/2/2019	palanti	ariatia	veja deng	Kareco	CE Bootis	hip 23395
6	15/2/2019	celeano	atlas	asterope	apishna	GQ Virginis	HIP 24046
6'	20/2/2019	judumlia	camulus	anca	ltt 911	ltt 5455	ross 409
7	21/2/2019	celaeno	atlas	asterope	apishna	GQ Virginis	HIP 24046
8	28/2/2019	badbadzist	eskite	songbe	apishna	lp 734-32	padhyas
9	1/3/2019	badbadzist	eskite	songbe	cd-54 471	lp 734-32	padhyas
10	8/3/2019	kambo	hip 10492	hip 4024	orang	ross 695	opila
11	14/3/2019	Tangua	HIP 9141	Turbacob	Cegreeth	61 Virginis	Ross 490

Table 2: Eagle Eye Targets considered for matching

Dates highlighted in lilac are considered for Redden's analysis, factabulous used all this data, but considered any system marked in lime as Optional (all others are Mandatory). The experimenters decided to use differing algorithms and data sets in order to avoid group-think and catch errors in their systems.

Note how a large section of the early data is all Optional in factabulous' data set, so the reduction in size of Redden's later data is not as extreme as it at first can sound.

Analysis Methods

Preliminary analysis

The initial analysis that led to the discovery of patterns followed by the Thargoid in their invasion of the bubble was triggered by the observation, mentioned in the introduction, that near the end of 3304, Thargoids seemingly stopped to target systems with ammonia resources (typically Ammonia Worlds and Gas Giants with Ammonia Based Life, with the occasional Water World or HMC world with ammonia in its atmosphere). At the time, this heuristic was used to identify targets whenever Eagle Eye would fail to detect them, or suffer an update delay, or error. By observing Thargoid-targeted systems (in the following often abbreviated as "thargets") after this strategy change, it is clear to see that such a backup detection solution would no longer be useful, as the Thargoid were moving each week to new thargets without any evident pattern. For these reasons, we decided to analyze Thargoid movements in order to try and identify hidden patterns that could allow us to predict their movements. All the following preliminary analysis have been conducted with data gathered from our Eagle Eye observers and using a local EDSM database mirror.

As can be seen in the targets table in Target Selection, the first 4 tracked updates to Eagle Eye after the strategy change (i.e., between 20/12/3304 and 24/1/3305) are a bit confusing: oftentimes, EE#1/2/3 are targeting systems in the Pleiades area, or are just a duplicate of EE#4/5/6. Furthermore, EE didn't update from 20/12 to 10/1, possibly due to a "winter break" taken by the Thargoids, while it once updated twice in a week (see updates 2 and 2'). For these reasons, the initial analysis focused solely on data collected after 24/1, when EE installations returned the Protocol Xeno 55 message [1], as such data looks somewhat stabler.

Geographical analysis

Before the strategy change at the end of 3304, Thargoids used to attack 3 systems per week and moved from one tharget to the next with varying jump ranges, but it was often the case that each new tharget would be near to at least one of the previous ones. For this reason, we began our preliminary analysis by looking at jump distances between new thargets.

EE		4	5	6
	System	HIP 9141	Bolg	HIP 21167
4	Kareco	**24**	148	157
5	CE Bootis	166	**15**	162
6	HIP 23395	144	143	**30**

EE		4	5	6
	System	Kareco	CE Bootis	HIP 23395
4	Apishna	**24**	150	148
5	GQ Virginis	144	**18**	162
6	HIP 24046	144	152	**5**

Just analyzing the movements of the first couple of weeks (i.e., 5 → 6, 6 → 7, in the tables above) yielded interesting results: it is clear to see that Thargoids are divided in three **columns** moving on three different **fronts**, each one performing small-ish jumps from one target to the next, i.e., from HIP 9141 to Kareco to Apishna, from Bolg to CE Bootis to GQ Virginis, from HIP 21667 to HIP 23395 to HIP 24046. Extending the analysis to the following weeks allows us to observe that not only such columns exist and consistently manifest the same jumping behavior, but also that each Eagle Eye installation always tracks the same column. Consequently, in the following of this article, we often identify a column with the identifier of the Eagle Eye installation that tracks it, e.g., the EE#4 column is HIP 9141 → Kareco → Apishna. It is possible to see the whole set of distances covered by different Columns in Appendix C.

Note that this analysis was first conducted when we had just a handful of available thargets, pointed by EE#4/5/6. In the same timeframe, EE#1/2/3 pointed twice to the Pleiades (weeks 4 and 6) and showed a somewhat anomalous set of thargets on week 5: Palanti, Ariatia, and Veja Deng (the latter being shown in a later update [5'] near the end of the week). These thargets are anomalous in that, contrarily to those in the three columns identified at the time (EE#4/5/6) that are quite apart from each other, they are very closely clustered. This actually questions the validity of the "columns theory" depicted above, but data gathered in the following weeks seems to confirms it. Indeed, while EE#1/2/3 columns departed from very close-by thargets, they are, at the time this article is being written, starting to diverge, evidently forming three distinct columns. For example, observing EE#/1/2/3 thargets for week 28/2 → 7/3 (reported in the table below), it is clear to see that systems pointed by the same EE (e.g., Badbadzist and Kambo) are still close after 2 updates, while systems pointed by different EE progressively got farther apart.

EE		1	2	3	4	5	6
	System	Badbadzist	Eskite	Songbe	CD-54 471	LP 734-32	Padhyas
1	Kambo	**12**	23	63	90	168	124
2	HIP 10492	27	**6**	44	79	164	131
3	HIP 4024	70	52	**13**	84	151	131
4	Orang	150	133	138	**60**	134	179
5	Ross 695	175	167	158	104	**2**	101
6	Opila	121	127	129	118	98	**8**

System characteristics analysis

Once we identified six different columns, we switched to trying to answer another question: can clustering the systems in columns help in identifying patterns, e.g., is there any other relation between systems in the same column, beyond the observed geographical proximity (or, better, galactigraphical)?

To answer this question, we first focused on seeing if any column was still going for ammonia, based on the fact that this was the main criterion before. It is worth remembering that, before the strategy change, Thargoids used to appear not only in directly targeted systems, but also in a cubic area of effect (AoE) of a given size centered around a tharget. For this reason, we looked for ammonia sources both in directly targeted systems and in those within an AoE around them and, once again, we focused on thargets *after* 24/1. The first search allowed to quickly identify that **all** EE#4 thargets have at least one Ammonia World, while all other columns just have occasional ammonia sources (GGWABLs, WWs and Icy worlds with ammonia atmosphere). The search within AoE unfortunately did not lead to particularly useful results, due to the density of ammonia sources that makes it so that, given a big enough AoE, more or less each tharget has an ammonia source within it. For this reason, we decided to discard this heuristic.

Finding this strong relation between ammonia worlds and column EE#4 does not prove that all columns are associated to a particular resource, but surely it indicates that it's worth to check for more patterns. For this reason, we tried to match more characteristics between systems in the same column, initially focusing on targetable stations types/economy, allegiance, security level, presence of pristine resource, and other body types.

This approach allowed to identify that all thargets in column EE#6 have at least one station with an **Agricultural** economy and at least either an ELW or a WW. This latter part of the pattern, however, looks quite weak given that almost all systems that host a station w/ Agricultural economy also have an ELW/WW, while the opposite (i.e., system with ELW/WW but no Agricultural stations) is quite frequent. Furthermore, all systems in this column have at least 4 HMCs, but given the high number of HMCs in the galaxy, this has been discarded as a casual incidence until further data is collected.

Looking at the station economy initially (i.e., in the first weeks) led to believe that column EE#5 was going for stations with High Tech economy, but this was disproved by later updates (20/2, 28/2, 7/3). Cross correlating multiple parameters per system allowed to identify that EE#5 goes after either High Tech or Military stations, but details of this methodology are discussed later.

Finally, it is worth noting that we used the preliminary analysis method described until now "on field" in week 28/2. In this case, EE#4 was **not** updated properly and kept pointing to an older system. This was a particularly hairy situation because the tharget was still under incursion, so we had no way of proving it was not part of that week set of thargets unless we found another system with NHSS (i.e., in an **infested** state). Luckily, EE#4 is a column for which we have a very solid pattern (Ammonia World), and it was possible to identify a very small set of candidates to manually scout for NHSS, by checking systems with a targetable station (Coriolis/Orbis/Ocellus) within the maximum range so far jumped by the column:

```
LHS 1380  (26Ly): Gurevich Orbital - Orbis Starport (Agriculture)
                  LHS 1380 A 4 - Ammonia world

Ngaiawang (30Ly): Dornier Terminal - Coriolis Starport (High Tech)
                  Ngaiawang 1 - Ammonia world

CD-54 471 (13Ly): KRAMSKI Holding - Orbis Starport (Industrial)
                  Brigsteer - Ammonia world
```

Visiting the systems allowed to successfully identify CD-54 471 as the proper EE#4 tharget for that week.

How the thargoids pick a tharget when there's more than one candidate available is still to be determined. This case is particularly interesting as there are so few candidates, among which only LHS 1380 had not been attacked before. The same system would've seemed to be an acceptable candidate even in previous week, when the column moved from LTT 911. Nonetheless, it was not chosen and we can only speculate that it was not to avoid a conflict with EE#6 that goes after Agriculture stations. Similarly, Ngaiawang could've been avoided to prevent conflicting with EE#5. Unfortunately, we do not have particular proofs for this idea and it must be treated as pure speculation until further analyses can be conducted.

factabulous

The decision was taken to write an analyser that runs over the data sets and checks for patterns in the data. A local database based on eddb was available and this was used as the source of information about the systems. The initial attributes that were tested were:

- Body types (Rocky, Icy, Ammonia World etc)
- Atmosphere Types (Ammonia-rich, Oxygen-rich etc)

We also tested for system reserves, star luminosity, temperature ranges, star class, but as these were found not to be useful they were removed at an early stage, it may be worth re-considering them now we have a more complex solution.

The above allowed us to reproduce data from Redden around Eagle Eye 4 and 6, as it correctly determined the Ammonia / Water World & Earth Like World relations, but as Redden had also found a relation to Agriculture we decided to add the following:

- System Economies (Agriculture, Industrial etc)
- Materials (Carbon, Niobium etc)

This now showed the Agriculture link to Eagle Eye 6, but gave another problem - generating the complete set of conditions for each criterion on its own would still not show Eagle Eye 4, as it requires the Body Types (Ammonia World, Ammonia Life Gas Giant and the Ammonia-rich atmosphere). It was decided to create a single attribute checker that would be given all attributes for all sets of data. This would then use an existing combination generator to create all possible combinations of attribute, which can then be checked.

This combined checker allowed Eagle Eye 4 to be confirmed without manually coding the set of parameters, but now we had the problem that we would get sometimes hundreds of matches. For instance Iron is found in most systems, so all Eagle Eyes would come back with Iron as a match, but this is not a ‘useful’ match as all non-targets would tend to also return Iron as a match - Iron is not *predictive.*

In order that we could surface interesting (i.e. unlikely) attribute sets we decided we needed to work out the likelihood of an attribute being found. Using our eddb dataset we calculated the values in Appendix A, and this then allowed us to work out the probability of a set of attributes appearing in the dataset by chance.

So for a test looking for two attributes we can multiply the two probabilities together to find the chance of the combination. Thus the chance of finding an Agriculture economy with a Methane Atmosphere planet in the same system is 0.08 * 0.29 so p(Agriculture and Methane) = 0.0232 - around 2%. But the chance of a Colony with a Methane Atmosphere planet is 0.31 * 0.29 = 0.899 - so around 9%.

This allowed us to list the top 10 least likely attribute combinations, which we did for one and two attributes. It should be clear that if a single attribute is found that matches all systems then it is likely the single attribute will be the one that can be used to determine target systems, unless it has a high probability.

At this stage we are discarding all Optional systems from the dataset (see Future Work for more on how we plan to change this).

Results

Eagle Eye	System Economy	Planet Types	Atmosphere Types
1	Industrial / Military		
2	Military / Terraforming		
3	Industrial / Military		
4		Ammonia World	Ammonia-rich
5	Military / High Tech		
6	Agriculture / High Tech		

Table 3: System Criterion

We found that in most cases the Economies present in a system determine which Eagle Eye will point to it, the exception being Eagle Eye 4, which continues to use Ammonia as the determinant (check it's results in Appendix B, the amount of Ammonia matches is very high). As noted previously Eagle Eye 6 matches both Agriculture and also Water World / Earth Like World. Analysis of the data in Agriculture systems has shown that the vast majority of Agriculture systems have one of these two planet types, and the probability of Agriculture Economy in an inhabited world is half that of one of the planet types, so we prefer Agriculture as the determinant until it is disproved. Also not that in the last week of data we were given the first target on EE#6 that does not match the Agriculture pattern - hence High Tech included in the match. It is yet to be seen if this is part of the same pattern, or if it is the start of a fresh pattern of targets.

It should also be noted that Eagle Eyes 1-3 are based on less data than 4-6, so are more open to change.

Limitations and Issues

There's a single, very recent, case that questions the validity of the results of both the geographic and system analyses, specifically in the EE#6 update of 14/3: Ross 490 is 99Ly away from the previous tharget of the column (Opila) and only 15Ly away from Ross 695 (EE#5). Furthermore, Ross 490 does not contain any Agriculture stations, so it also violates the pattern for EE#6, while contains High Tech stations, a match for EE#5. At this time, we can only speculate why EE#6 column was apparently paused while EE#5 got a double tharget, but if this behavior is confirmed in forthcoming weeks, we may need to revise the hypothesis that each column is associated to a single EE. It is worth, if a bit tinfoil-ish, to note that Opila did **not** transition from Pending Incursion to Incursion. Not having any way of knowing if the infestation was cured, we can't really make any conclusion, but it's an interesting coincidence that leads to a lot of speculations, alas destined to remain in the

tinfoil realm until we can gather more data (this is the first unsuccessful infestation since 22/1).

Future Work

There are several areas that need more work, listed below for reference.

Optional Systems

factabulous' attribute analyser discards all Optional systems. This is partially because we found there was no need for them, but mainly because it complicates the probability calculation. This is because at the moment the probability of a set of attributes is the same for all mandatory systems (as they all match one or more of the sets of attributes). Ideally we would include optional (for the extra data points), but it is probable that not all optional systems would fit all attributes - so the comparison of probabilities to display the 'most likely' is complicated.

Distances & Directions

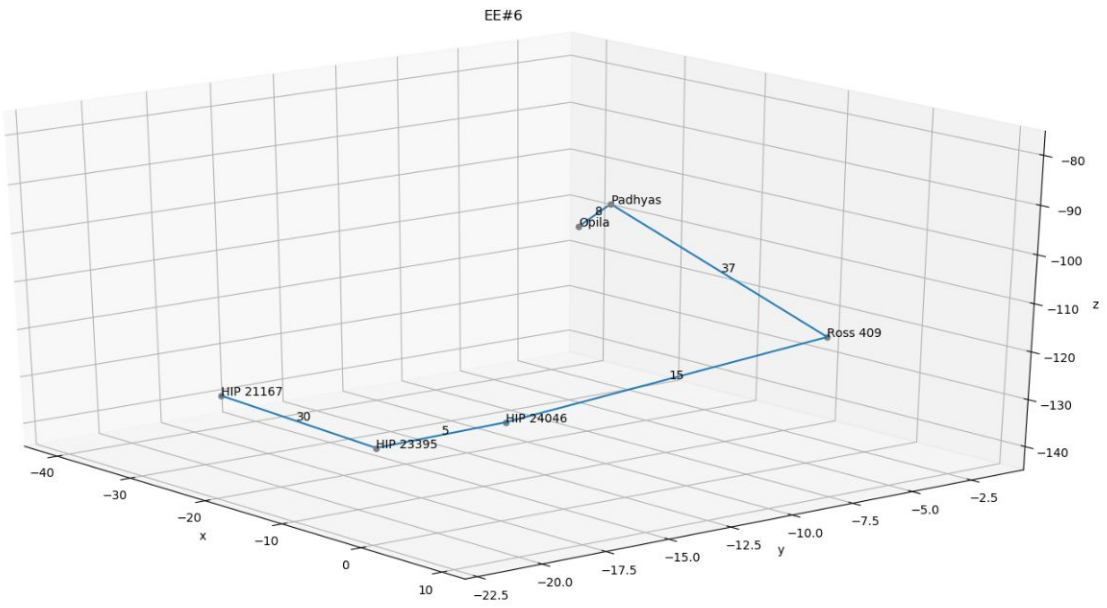
A first analysis of direction of movement of a column was conducted by looking at the the coordinates of the systems, reducing these movements to +/- indicators for each axis and deciding if they are consistent. At first, this gave somewhat promising results, for example observing a subsection of EE#6 (number is distance in Lys):

```
HIP 21167 -(30)(+-+)-> HIP 23395
HIP 23395 -(05)(+++)-> HIP 24046
HIP 24046 -(15)(+++)-> Ross 409
Ross 409  -(37)(+-+)-> Padhyas
Padhyas   -(08)(+-+)-> Opila
```

One could see that the column is consistently moving towards higher coordinates on both x and z axes, while wobbling a bit over the y axis. However, this is a very very rough indication of a general direction, for example two consecutive +++ will tell us that the column didn't do a U turn, but not much more. Consider this case: given two consecutive thargets in a column A and B, whether they're linked by vector $AB = (1, 1, 1)$ or $AB = (100, 1, 1)$ using simple +/- indicators will give us a +++ but it's clear to see that the precise direction will vary greatly. For this reason, we switched to more accurate direction indicators, such as measuring vectors angles and direction cosines and observing how they vary between different jumps. By sticking to the same use case above (EE#6), for example, we can observe the following direction cosines:

```
HIP 21167 -(30)(α:98,β:-9,γ:17)-> HIP 23395
HIP 23395 -(05)(α:17,β:95,γ:23)-> HIP 24046
HIP 24046 -(15)(α:21,β:80,γ:55)-> Ross 409
Ross 409  -(37)(α:4,β:-25,γ:96)-> Padhyas
Padhyas   -(08)(α:88,β:-44,γ:15)-> Opila
```

As it's clear to see from the significative differences in the direction cosines and with the help of the figure below, the direction between different jumps varies greatly. It's possible to observe that all other columns don't seem to follow a particular direction either in Appendix D - Visualizing directions.



This is quite unfortunate, as we were hoping to use directions in order to reduce the size of the set of predicted thargets for a column. Similarly, there seems to be no particular pattern in the jump distances: some columns such as EE#1 and EE#5 seem to stick to short (<=20) jump ranges, while others (e.g., EE#6) have a high variance, alternating short and long jumps (60, 99 being the maximum recorded so far).

As the saying goes, *necessity is the mother of invention*, and factabulous came up with another quite interesting hypothesis: rather than following a particular direction, or trying to reach a particular destination, each column is moving within a limited area which, considering our past observations of thargoid behaviors could either be spheric (the Merope bubble) or cubic (the cubic AoE, explained earlier). The idea looks promising although, with the limited data at our disposal, it's hard to say whether we'll be able to use it to help predictions any time soon.

Determining if preventing an incursion influences a column

Due to the lack of actual data we can only speculate about the possibility that successfully preventing a tharget from entering an incursion state could have an impact on the next tharget selection. The repentine change of EE#6 in week 14/3 (see Limitations and Issues) could have been triggered by Opila not entering incursion state but there's no proof for this yet, as we all know, *correlation doesn't imply causation*. We need to defend more infested systems in order to gather more evidence and further investigate the possibility.

References

[1] Canonn Site for Eagle Eye: https://canonn.science/codex/eagle-eye-installations/

Appendices

Appendix A : Likelihood of Attributes appearing in a populated system

Note that where a percentage is 0 it is treated as 0.1. Economy looks at all the economies present across a target system.

Classification	Attribute	Percentage
Economy	Agriculture	8
	Colony	31
	Extraction	59
	High Tech	4
	Industrial	31
	Military	28
	Refinery	51
	Service	0
	Terraforming	7
	Tourism	1
Body Type	Helium-rich gas giant	0
	Ammonia world	1
	Black hole	0
	Water world	12
	Neutron star	0
	Gas giant with water-based life	13
	Metal-rich body	9
	Class IV gas giant	2
	Water giant	0
	Gas giant with ammonia-based life	9
	Earth-like world	9

	Class III gas giant	20
	Class II gas giant	15
	High metal content world	73
	Class V gas giant	0
	Icy body	82
	Rocky body	41
	Class I gas giant	44
	Rocky ice world	22
Atmosphere Type	Methane	29
	Argon-rich	33
	Carbon dioxide-rich	10
	No atmosphere	89
	Sulphur dioxide	27
	Neon-rich	22
	Water-rich	1
	Silicate vapour	3
	Oxygen	1
	Helium	36
	Nitrogen	29
	Suitable for water based life	9
	Argon	19
	Methane-rich	28
	Neon	10
	Ammonia-rich	6
	Ammonia and oxygen	1
	Metallic vapour	0
	Ammonia	10
	Carbon dioxide	41
	Water	15
Material	Technetium	58
	Sulphur	99

	Germanium	86
	Zinc	88
	Vanadium	86
	Polonium	51
	Niobium	86
	Mercury	78
	Tellurium	74
	Nickel	99
	Tin	85
	Selenium	82
	Ruthenium	73
	Arsenic	71
	Tungsten	83
	Carbon	99
	Manganese	92
	Zirconium	72
	Cadmium	88
	Antimony	70
	Chromium	93
	Yttrium	73
	Molybdenum	85
	Phosphorus	99
	Iron	100

Appendix B : factabuous calculated attributes

This is the raw output from the calculation of attribute sets. The Eagle Eye installations are in order. These are the top 10 matches, but it should be noted that not all combinations are deemed interesting - for instance the ‘best’ match for EE1 is the combination of a Industrial Economy and a Water atmosphere. Looking down the list the more interesting (entry is the one that shows the all systems for EE1 have either a Military or Industrial Economy.

```
EE1 : 2 Attribute(s) 5 Mandatory systems, 5 Total systems, 193 Total matches found
  p('Water' and 'Industrial') = 0.4600 v('Water', 'Industrial')
    p(Water)=0.1500 (2 systems match)
    p(Industrial)=0.3100 (3 systems match)
  p('Military' and 'Industrial') = 0.5900 v('Military', 'Industrial')
    p(Military)=0.2800 (4 systems match)
    p(Industrial)=0.3100 (3 systems match)
  p('Argon-rich' and 'Military') = 0.6100 v('Argon-rich', 'Military')
    p(Argon-rich)=0.3300 (2 systems match)
```

```
    p(Military)=0.2800 (4 systems match)
  p('Industrial' and 'Colony') = 0.6200 v('Industrial', 'Colony')
    p(Industrial)=0.3100 (3 systems match)
    p(Colony)=0.3100 (3 systems match)
  p('Argon-rich' and 'Colony') = 0.6400 v('Argon-rich', 'Colony')
    p(Argon-rich)=0.3300 (2 systems match)
    p(Colony)=0.3100 (3 systems match)
  p('Military' and 'Carbon dioxide') = 0.6900 v('Military', 'Carbon dioxide')
    p(Military)=0.2800 (4 systems match)
    p(Carbon dioxide)=0.4100 (2 systems match)
  p('Military' and 'Rocky body') = 0.6900 v('Military', 'Rocky body')
    p(Military)=0.2800 (4 systems match)
    p(Rocky body)=0.4100 (3 systems match)
  p('Rocky body' and 'Nitrogen') = 0.7000 v('Rocky body', 'Nitrogen')
    p(Rocky body)=0.4100 (3 systems match)
    p(Nitrogen)=0.2900 (3 systems match)
  p('Industrial' and 'Rocky body') = 0.7200 v('Industrial', 'Rocky body')
    p(Industrial)=0.3100 (3 systems match)
    p(Rocky body)=0.4100 (3 systems match)
  p('High metal content world' and 'Class IV gas giant') = 0.7500 v('High metal
content world', 'Class IV gas giant')
    p(High metal content world)=0.7300 (5 systems match)
    p(Class IV gas giant)=0.0200 (1 systems match)
EE2 : 2 Attribute(s) 5 Mandatory systems, 5 Total systems, 247 Total matches found
  p('Ammonia and oxygen' and 'Military') = 0.2900 v('Ammonia and oxygen',
'Military')
    p(Ammonia and oxygen)=0.0100 (1 systems match)
    p(Military)=0.2800 (5 systems match)
  p('Ammonia world' and 'Military') = 0.2900 v('Ammonia world', 'Military')
    p(Ammonia world)=0.0100 (1 systems match)
    p(Military)=0.2800 (5 systems match)
  p('Military' and 'Terraforming') = 0.3500 v('Military', 'Terraforming')
    p(Military)=0.2800 (5 systems match)
    p(Terraforming)=0.0700 (2 systems match)
  p('Agriculture' and 'Military') = 0.3600 v('Agriculture', 'Military')
    p(Agriculture)=0.0800 (1 systems match)
    p(Military)=0.2800 (5 systems match)
  p('Military' and 'Gas giant with ammonia-based life') = 0.3700 v('Military', 'Gas
giant with ammonia-based life')
    p(Military)=0.2800 (5 systems match)
    p(Gas giant with ammonia-based life)=0.0900 (1 systems match)
  p('Military' and 'Suitable for water based life') = 0.3700 v('Military',
'Suitable for water based life')
    p(Military)=0.2800 (5 systems match)
    p(Suitable for water based life)=0.0900 (1 systems match)
  p('Military' and 'Earth-like world') = 0.3700 v('Military', 'Earth-like world')
    p(Military)=0.2800 (5 systems match)
    p(Earth-like world)=0.0900 (1 systems match)
  p('Military' and 'Ammonia') = 0.3800 v('Military', 'Ammonia')
    p(Military)=0.2800 (5 systems match)
    p(Ammonia)=0.1000 (1 systems match)
  p('Industrial' and 'Terraforming') = 0.3800 v('Industrial', 'Terraforming')
    p(Industrial)=0.3100 (3 systems match)
    p(Terraforming)=0.0700 (2 systems match)
```

```
  p('Military' and 'Carbon dioxide-rich') = 0.3800 v('Military', 'Carbon
dioxide-rich')
    p(Military)=0.2800 (5 systems match)
    p(Carbon dioxide-rich)=0.1000 (2 systems match)
EE3 : 2 Attribute(s) 6 Mandatory systems, 6 Total systems, 103 Total matches found
  p('Industrial' and 'Gas giant with ammonia-based life') = 0.4000 v('Industrial',
'Gas giant with ammonia-based life')
    p(Industrial)=0.3100 (5 systems match)
    p(Gas giant with ammonia-based life)=0.0900 (1 systems match)
  p('Metal-rich body' and 'Industrial') = 0.4000 v('Metal-rich body', 'Industrial')
    p(Metal-rich body)=0.0900 (1 systems match)
    p(Industrial)=0.3100 (5 systems match)
  p('Industrial' and 'Carbon dioxide-rich') = 0.4100 v('Industrial', 'Carbon
dioxide-rich')
    p(Industrial)=0.3100 (5 systems match)
    p(Carbon dioxide-rich)=0.1000 (1 systems match)
  p('Ammonia and oxygen' and 'Carbon dioxide') = 0.4200 v('Ammonia and oxygen',
'Carbon dioxide')
    p(Ammonia and oxygen)=0.0100 (1 systems match)
    p(Carbon dioxide)=0.4100 (5 systems match)
  p('Ammonia world' and 'Carbon dioxide') = 0.4200 v('Ammonia world', 'Carbon
dioxide')
    p(Ammonia world)=0.0100 (1 systems match)
    p(Carbon dioxide)=0.4100 (5 systems match)
  p('Industrial' and 'Argon') = 0.5000 v('Industrial', 'Argon')
    p(Industrial)=0.3100 (5 systems match)
    p(Argon)=0.1900 (2 systems match)
  p('Neon-rich' and 'Industrial') = 0.5300 v('Neon-rich', 'Industrial')
    p(Neon-rich)=0.2200 (2 systems match)
    p(Industrial)=0.3100 (5 systems match)
  p('Reserves pristine' and 'Carbon dioxide') = 0.5800 v('Reserves pristine',
'Carbon dioxide')
    p(Reserves pristine)=0.1700 (1 systems match)
    p(Carbon dioxide)=0.4100 (5 systems match)
  p('Industrial' and 'Sulphur dioxide') = 0.5800 v('Industrial', 'Sulphur dioxide')
    p(Industrial)=0.3100 (5 systems match)
    p(Sulphur dioxide)=0.2700 (2 systems match)
  p('Military' and 'Industrial') = 0.5900 v('Military', 'Industrial')
    p(Military)=0.2800 (5 systems match)
    p(Industrial)=0.3100 (5 systems match)
EE4 : 2 Attribute(s) 10 Mandatory systems, 10 Total systems, 105 Total matches
found
  p('Ammonia world' and 'Ammonia-rich') = 0.0700 v('Ammonia world', 'Ammonia-rich')
    p(Ammonia world)=0.0100 (9 systems match)
    p(Ammonia-rich)=0.0600 (2 systems match)
  p('Ammonia and oxygen' and 'Ammonia-rich') = 0.0700 v('Ammonia and oxygen',
'Ammonia-rich')
    p(Ammonia and oxygen)=0.0100 (9 systems match)
    p(Ammonia-rich)=0.0600 (2 systems match)
  p('Ammonia world' and 'Terraforming') = 0.0800 v('Ammonia world', 'Terraforming')
    p(Ammonia world)=0.0100 (9 systems match)
    p(Terraforming)=0.0700 (3 systems match)
  p('Ammonia and oxygen' and 'Terraforming') = 0.0800 v('Ammonia and oxygen',
'Terraforming')
```

```
    p(Ammonia and oxygen)=0.0100 (9 systems match)
    p(Terraforming)=0.0700 (3 systems match)
  p('Water world' and 'Ammonia and oxygen') = 0.1300 v('Water world', 'Ammonia and
oxygen')
    p(Water world)=0.1200 (4 systems match)
    p(Ammonia and oxygen)=0.0100 (9 systems match)
  p('Water world' and 'Ammonia world') = 0.1300 v('Water world', 'Ammonia world')
    p(Water world)=0.1200 (4 systems match)
    p(Ammonia world)=0.0100 (9 systems match)
  p('Ammonia and oxygen' and 'Water') = 0.1600 v('Ammonia and oxygen', 'Water')
    p(Ammonia and oxygen)=0.0100 (9 systems match)
    p(Water)=0.1500 (2 systems match)
  p('Ammonia world' and 'Water') = 0.1600 v('Ammonia world', 'Water')
    p(Ammonia world)=0.0100 (9 systems match)
    p(Water)=0.1500 (2 systems match)
  p('Ammonia and oxygen' and 'Military') = 0.2900 v('Ammonia and oxygen',
'Military')
    p(Ammonia and oxygen)=0.0100 (9 systems match)
    p(Military)=0.2800 (8 systems match)
  p('Ammonia world' and 'Methane-rich') = 0.2900 v('Ammonia world', 'Methane-rich')
    p(Ammonia world)=0.0100 (9 systems match)
    p(Methane-rich)=0.2800 (5 systems match)
EE5 : 2 Attribute(s) 10 Mandatory systems, 10 Total systems, 66 Total matches found
  p('Military' and 'Class IV gas giant') = 0.3000 v('Military', 'Class IV gas
giant')
    p(Military)=0.2800 (9 systems match)
    p(Class IV gas giant)=0.0200 (3 systems match)
  p('Military' and 'High Tech') = 0.3200 v('Military', 'High Tech')
    p(Military)=0.2800 (9 systems match)
    p(High Tech)=0.0400 (5 systems match)
  p('Metal-rich body' and 'Military') = 0.3700 v('Metal-rich body', 'Military')
    p(Metal-rich body)=0.0900 (1 systems match)
    p(Military)=0.2800 (9 systems match)
  p('Reserves common' and 'Military') = 0.4100 v('Reserves common', 'Military')
    p(Reserves common)=0.1300 (5 systems match)
    p(Military)=0.2800 (9 systems match)
  p('Military' and 'Sulphur dioxide') = 0.5500 v('Military', 'Sulphur dioxide')
    p(Military)=0.2800 (9 systems match)
    p(Sulphur dioxide)=0.2700 (3 systems match)
  p('Methane-rich' and 'Military') = 0.5600 v('Methane-rich', 'Military')
    p(Methane-rich)=0.2800 (2 systems match)
    p(Military)=0.2800 (9 systems match)
  p('Argon-rich' and 'Military') = 0.6100 v('Argon-rich', 'Military')
    p(Argon-rich)=0.3300 (3 systems match)
    p(Military)=0.2800 (9 systems match)
  p('Technetium' and 'High Tech') = 0.6200 v('Technetium', 'High Tech')
    p(Technetium)=0.5800 (7 systems match)
    p(High Tech)=0.0400 (5 systems match)
  p('Military' and 'Helium') = 0.6400 v('Military', 'Helium')
    p(Military)=0.2800 (9 systems match)
    p(Helium)=0.3600 (4 systems match)
  p('Tellurium' and 'Class IV gas giant') = 0.7600 v('Tellurium', 'Class IV gas
giant')
    p(Tellurium)=0.7400 (8 systems match)
```

```
    p(Class IV gas giant)=0.0200 (3 systems match)
EE6 : 2 Attribute(s) 10 Mandatory systems, 10 Total systems, 137 Total matches
found
  p('Agriculture' and 'High Tech') = 0.1200 v('Agriculture', 'High Tech')
    p(Agriculture)=0.0800 (9 systems match)
    p(High Tech)=0.0400 (1 systems match)
  p('Reserves common' and 'Agriculture') = 0.2100 v('Reserves common',
'Agriculture')
    p(Reserves common)=0.1300 (1 systems match)
    p(Agriculture)=0.0800 (9 systems match)
  p('Agriculture' and 'Argon') = 0.2700 v('Agriculture', 'Argon')
    p(Agriculture)=0.0800 (9 systems match)
    p(Argon)=0.1900 (4 systems match)
  p('Agriculture' and 'Methane') = 0.3700 v('Agriculture', 'Methane')
    p(Agriculture)=0.0800 (9 systems match)
    p(Methane)=0.2900 (2 systems match)
  p('Class I gas giant' and 'Agriculture') = 0.5200 v('Class I gas giant',
'Agriculture')
    p(Class I gas giant)=0.4400 (4 systems match)
    p(Agriculture)=0.0800 (9 systems match)
  p('Agriculture' and 'Polonium') = 0.5900 v('Agriculture', 'Polonium')
    p(Agriculture)=0.0800 (9 systems match)
    p(Polonium)=0.5100 (2 systems match)
  p('Agriculture' and 'Refinery') = 0.5900 v('Agriculture', 'Refinery')
    p(Agriculture)=0.0800 (9 systems match)
    p(Refinery)=0.5100 (3 systems match)
  p('Agriculture' and 'Technetium') = 0.6600 v('Agriculture', 'Technetium')
    p(Agriculture)=0.0800 (9 systems match)
    p(Technetium)=0.5800 (4 systems match)
  p('High metal content world' and 'High Tech') = 0.7700 v('High metal content
world', 'High Tech')
    p(High metal content world)=0.7300 (9 systems match)
    p(High Tech)=0.0400 (1 systems match)
  p('Agriculture' and 'Antimony') = 0.7800 v('Agriculture', 'Antimony')
    p(Agriculture)=0.0800 (9 systems match)
    p(Antimony)=0.7000 (4 systems match)
```

Appendix C - All distances for weeks post 24/1

EE		1	2	3	4	5	6
	System	-	-	-	HIP 9141	Bolg	HIP 21167
1	Palanti	-	-	-	60.11	191.15	125.14
2	Ariatia	-	-	-	61.89	192.44	124.79
3	Veja Deng	-	-	-	61.35	181.14	114.31
4	Kareco	-	-	-	24.87	148.93	157.10
5	CE Bootis	-	-	-	166.71	15.51	162.59
6	HIP 23395	-	-	-	144.54	143.70	30.48

EE		1	2	3	4	5	6
	System	Palanti	Ariatia	Veja Deng	Kareco	CE Bootis	HIP 23395
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	Apishna	92.43	92.41	92.05	24.93	150.04	148.49
5	GQ Virginis	197.56	198.73	188.69	144.40	18.95	162.30
6	HIP 24046	121.52	120.22	111.25	144.89	152.66	5.07

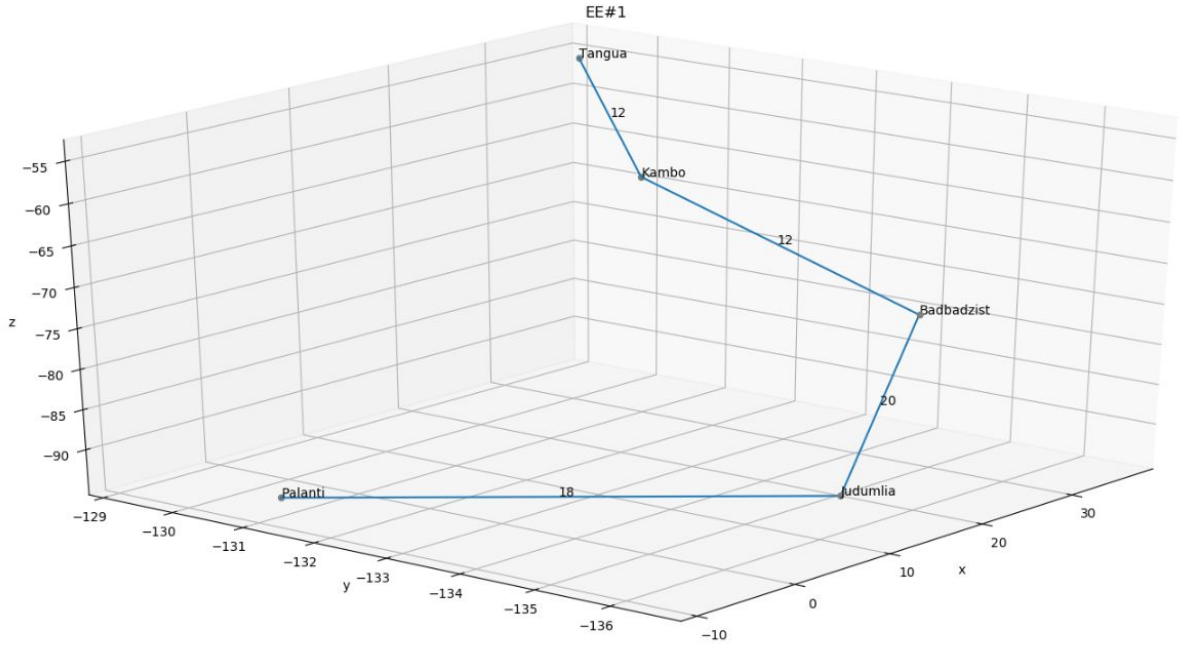
EE		1	2	3	4	5	6
	System	-	-	-	Apishna	GQ Virginis	HIP 24046
1	Judumlia	-	-	-	82.09	198.59	128.67
2	Camulus	-	-	-	65.75	184.52	137.86
3	Anca	-	-	-	76.67	185.89	142.65
4	LTT 911	-	-	-	34.10	123.75	164.83
5	LTT 5455	-	-	-	135.40	10.06	152.63
6	Ross 409	-	-	-	151.18	148.47	15.01

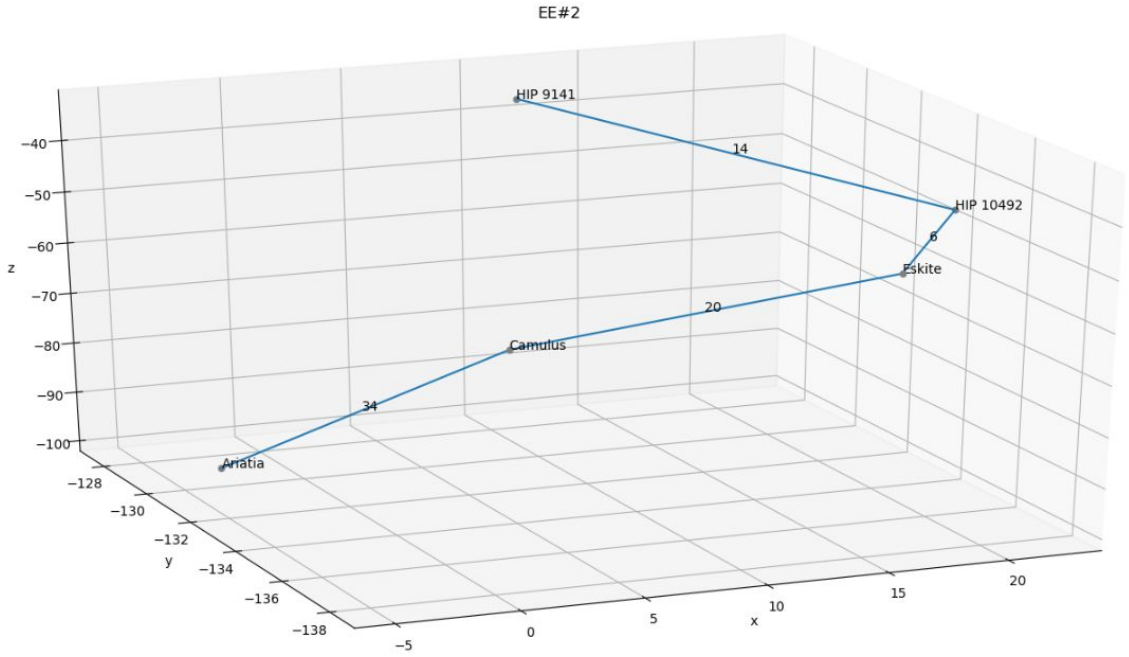
EE		1	2	3	4	5	6
	System	Judumlia	Camulus	Anca	LTT 911	LTT 5455	Ross 409
1	Badbadzist	20.74	18.57	37.18	93.37	178.91	143.73
2	Eskite	41.83	20.12	32.40	76.45	170.13	154.70
3	Songbe	68.32	42.76	31.55	79.25	158.61	158.29
4	CD-54 471	117.45	99.17	106.02	13.68	105.50	157.85

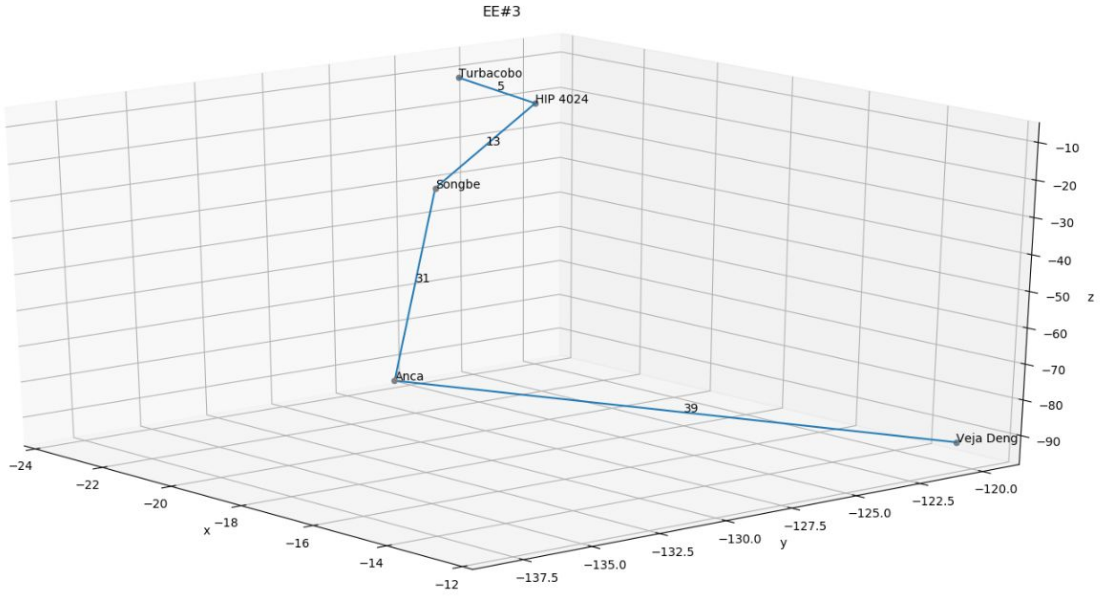
5	LP 734-32	184.45	172.07	174.69	115.46	13.30	131.67
6	Padhyas	124.21	125.00	129.08	130.03	109.06	37.09
EE		1	2	3	4	5	6
	System	Badbadzist	Eskite	Songbe	CD-54 471	LP 734-32	Padhyas
1	Kambo	12.84	23.66	63.01	90.15	168.72	124.01
2	HIP 10492	27.34	6.85	44.87	79.25	164.55	131.56
3	HIP 4024	70.68	52.25	13.55	84.04	151.21	131.66
4	Orang	150.18	133.38	138.89	60.65	134.33	179.96
5	Ross 695	175.46	167.92	158.69	104.40	2.75	101.78
6	Opila	121.29	127.47	129.22	118.90	98.77	8.04

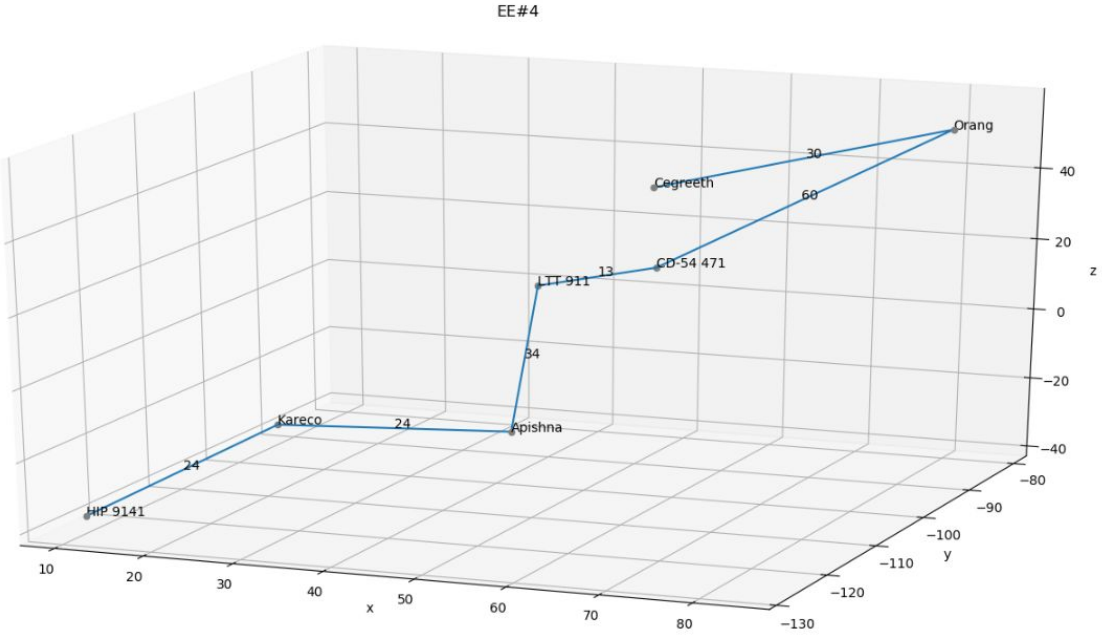
EE		1	2	3	4	5	6
	System	Kambo	HIP 10492	HIP 4024	Orang	Ross 695	Opila
1	Tangua	12.27	19.40	70.47	127.63	163.40	120.63
2	HIP 9141	35.13	14.83	39.47	123.52	154.80	121.59
3	Turbacobo	77.21	57.19	5.50	130.78	151.04	133.25
4	Cegreeth	122.63	106.42	108.49	30.88	142.54	173.10
5	61 Virginis	170.67	165.32	149.62	132.38	6.35	104.46
6	Ross 490	173.05	168.09	150.25	143.65	15.66	99.92

Appendix D - Visualizing directions

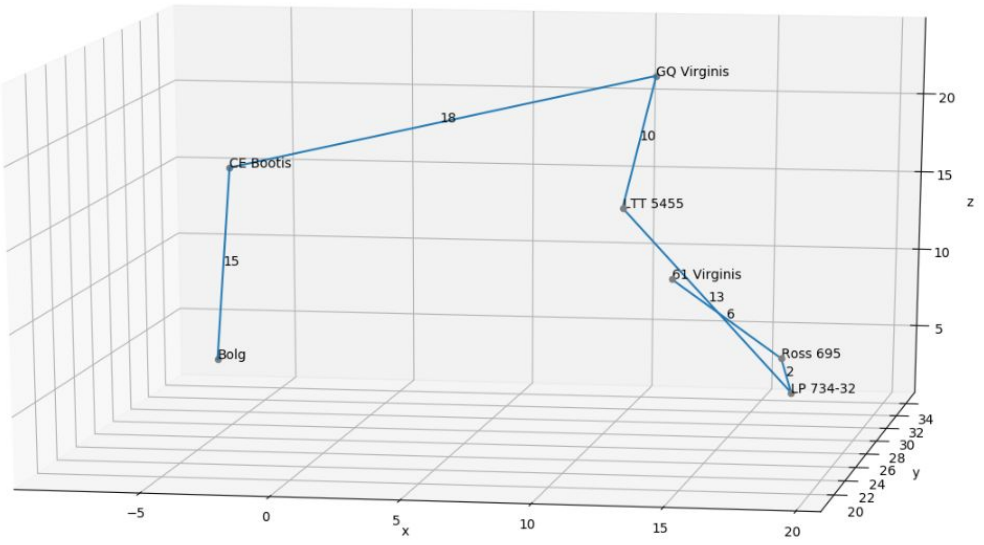




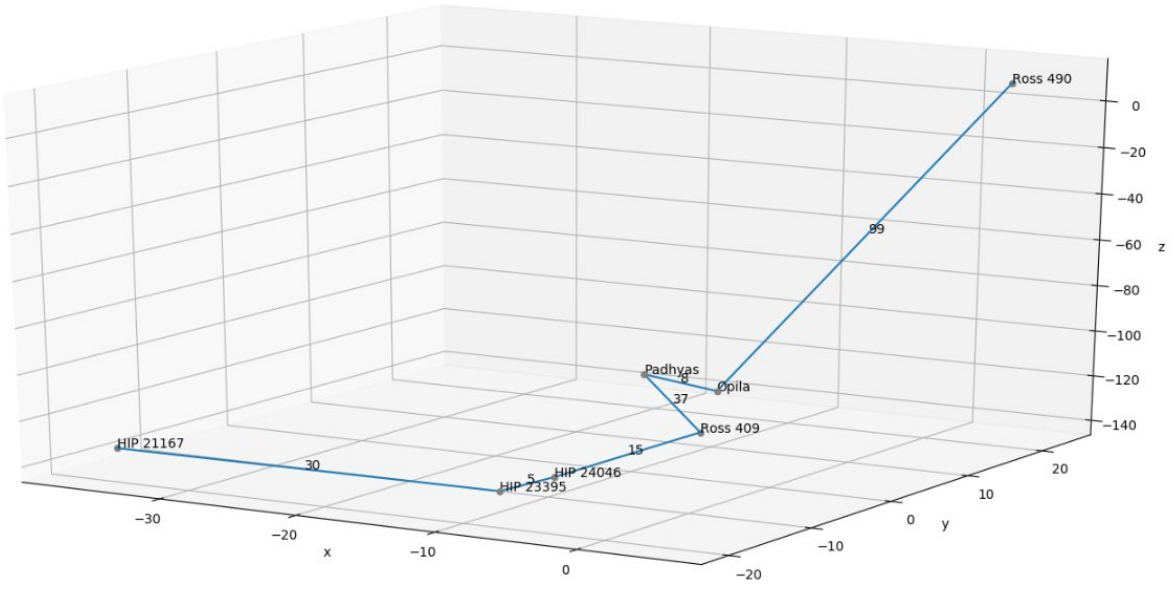

EE#3
Turbacobo
5
HIP 4024
13
Songbe
31
Anca
39
Veja Deng
x
y
z

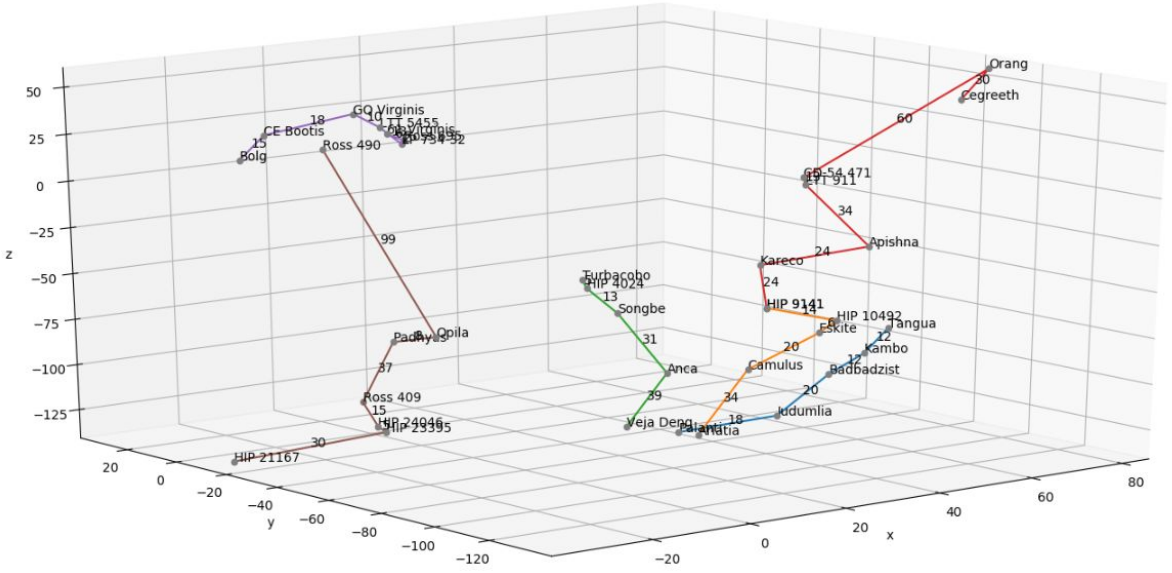

EE#4
Orang
30
Cegreeth
60
CD-54 471
13
LTT 911
34
Kareco
24
Apishna
24
HIP 9141
x
y
z

EE#5


GQ Virginis
18
10
CE Bootis
LTT 5455
15
61 Virginis
13
6
Bolg
Ross 695
2
LP 734-32
x
y
z

EE#6


Ross 490
99
Padhyas
8
Øpila
37
Ross 409
15
HIP 21167
30
5
HIP 24046
HIP 23395
x
y
z


EE#1/2/3/4/5/6
Orang
Cegreeth
GQ Virginis
CE Bootis
Bolg
Ross 490
Apishna
Kareco
Turbacoho
HIP 4024
Songbe
HIP 9141
HIP 10492
Tangua
Eskite
Kambo
Camulus
Badbadzist
Anca
Ross 409
HIP 21167
Judumlia
Veja Deng
Opila
x
y
z