Data selection and extraction for the TRIPS star map, August 2019.

We begin with the understanding that the job I was asked to do: “Provide a 3d location for every stellar object out to 300 light years” is impossible. There are a huge number of obstacles. Out to about 100 LY, curating the list isn’t that hard, all objects brighter than “M” class dwarf stars are well known. Even the Ms are well known out to 40 or 50 LY. The list can be derived from many sources. Although it hasn’t been updated since 2014, the list developed by Jo Grant at <http://www.solstation.com/stars.htm> is an excellent place to start. It is complete out to 33 LY, and nearly so out to 65 LY.

After that, we need to start looking at actual catalogs of objects developed by astronomers over the last couple of hundred years. Fortunately for us the folks at Centre de Données astronomiques de Strasbourg (Strasbourg Astronomical Data Center – known to space folk as CDS) have been gathering every astronomical catalog published and digitizing them where they were printed on paper.

Additionally the folks at CDS have taken on another Herculean task. For almost two decades they’ve chained graduate students to desks and created a cross-referenced, combined catalog of essentially every object mentioned in a peer-reviewed paper published in an astronomical journal since 1860. So, if you’re interested in a high proper motion star like *2MASS J14185217+2431174* you can look it up and find every published reference to it and its catalog id in every other catalog that it’s been cross-referenced to. Cool. They are however very clear that “Simbad doesn’t contain everything” it contains objects that have been mentioned in peer reviewed papers. Still Simbad provides a good place for us to start… it’s well curated and easy to access at <http://simbad.u-strasbg.fr/simbad/>

So, the first step was to query Simbad for everything with a parallax of more than 11 milli-arc-seconds, everything closer to us than 300 LY.

That gets us a list of a little over 40,000 objects, almost all with position, spectral type, surface temp, and object type (star, flare star, dwarf, etc…)

BUT

In 2013 the European Space Agency launched the Gaia observatory. It’s designed specifically for astrometry and is intended to measure the positions, distances and motions of objects with unprecidented precision all the way down to objects with a visual magnetude of 20. (very dim) You just have to assume that they’ve located objects within 300 ly that weren’t in the previously published catalogs, and by golly they have. There are however, “problems”. The Gaia group has released data twice, the most recent in 2018 callled “Data Release 2”. (Astronomers are well known for their clever naming systems. Giant red stars are called “red giants.” Dwarf white stars are called “white dwarfs.” etc, etc.) They are the first to tell you tho, that DR2 is the result of only 22 months of data collection out of a planned 60 and that there are lots of “bad” data points in the data such as the 59 objects they list closer than Proxima Centauri. (oops)

They’ve made a valiant attempt to cross-match the Gaia objects with objects from other catalogs, and so MOST of the objects we found in our SIMBAD search can be cross-matched with objects from the Gaia data. (all but about 1800 of them) Then, we can throw out data points with “bad” distances where the calculation was clearly wrong. We somewhat arbitrarily set the limit at “the parallax has to be at least 10 times the stated potential parallax error.”

Then, we applied a second filter that deleted from the Gaia list any object not already cross matched that was within 0.8 light years of another star (except for binaries and such of course)

Our third filter removed objects from the Gaia list

1. where the apparent visual magnitude was dimmer than 16. While Gaia goes down to 20 we decided that objects closer than 300 ly just shouldn’t be that dim… we might be wrong, but we had to use some standard. And
2. it was impossible to calculated an effective temperature because the object was so dim that it was impossible to get photon fluxes in either the B or R filter bands.

In general we think that the objects tossed out in the third filter were the result of two dim objects so close together that the Gaia spacecraft mistook them for a single object with parallax. Those will doubtless be fixed in Data Release 3 in 2021, but we need a star map now.

At that point then, we took the Gaia “effective temperature” and radius information and used that to assign a spectral type to the Gaia objects that didn’t have one using the standard MKS spectral type definitions dating back to Annie Jump Cannon at Harvard in the late 1800’s.

The eventual result was 140,413 objects. Of those 42472 are “new” from Gaia DR2 and 1856 are from Simbad and have no cross-match in Gaia.

Of the 140 thousand objects 100093 have spectral types assigned by us rather than from a published source (noted by having a ? following their spectral type).

The objects are distributed throughout the various distance shells as follows:

Shell Count

10 14

20 111

30 191

40 398

50 640

60 935

70 1245

80 1584

90 1891

100 2235

125 7281

150 9911

175 12700

200 14874

225 17653

250 21001

275 24237

300 23515