

I am very interested in computer science and astronomy and would like to participate in the Young Engineers and Scientist (YES) program to learn about research in space technology and exploration. For my independent research project, I want to use computer programming to create an educational tool for astronomy that I can eventually put on the internet. I am currently programming a version of this tool that calculates information about a star from observed data and then classifies the star in the proper luminosity class and spectral type.

As my application is supposed to be an educational tool for astronomy, only a minimum amount of data should be inputted. The three types of input data my application accepts are the apparent magnitude, the distance, and the BV color index. The apparent magnitude measures how bright a star appears when seen from Earth. The distance measures how far away a star is in light years. The BV color index is the ratio of blue light to visible light emitted by the star. My program allows the user to input these measurements to calculate more data about the star. (See Figure 1.)

To be useful my application has to accurately calculate as much data as possible from its three inputs. The information that my application can currently calculate are the absolute magnitude, luminosity, temperature, and radius. The absolute magnitude is calculated from the star's apparent magnitude and its distance in lightyears using and this equation:

$$M_{Abso M} = m_{App m} - 5 \log \left[\frac{d}{10 \text{ pc}} \right].$$

The luminosity is calculated from the star's absolute magnitude, the Sun's luminosity (L_{\odot}), the Sun's absolute magnitude (M_{\odot}) using this equation:

$$L_S = L_{\odot} * 10^{0.4(M_{\odot} - M_S)}.$$

The temperature is calculated from the star's BV color index and an equation and constants found in two papers by Phillip Flower¹ and Guillermo Torres².

The radius is calculated from the star's luminosity, its temperature, and Stefan's constant $\sigma = 5.67 * 10^{-8} \frac{\text{W}}{\text{m}^2\text{K}^4}$ using this equation:

$$R = \sqrt{\frac{L}{4\pi\sigma T^4}}.$$

For my short-term project, I want to add to and refine my application's features and improve the accuracy of my calculations. Among the features I wish to add to my application are the ability to input distance in other units such as meters and parsecs and the option to select units for some outputs. I want to be able to calculate more outputs such as the star's mass, color, and classification. I also want to add icons for the stars, save star data to a file and read it back, and create more example stars.

My application closely or accurately calculates data for some known stars such as Tau Ceti, Alpha Centauri A, Sirius A, Betelgeuse, and Deneb but produces very different results with stars such as Regulus A, Rigel, Bellatrix, and Mintaka A. (See Table 1.) I would like to work with an astronomer to help refine my calculations and produce accurate data. I would also like to work with an astronomer for help with accurately classifying stars and adding more calculations.

For a more long-term project a want to be able to recreate my program in Python on the Raspberry Pi and put it on the internet.

¹ Transformations from Theoretical HR Diagrams to Color-Magnitude Diagrams. Philip J. Flower, The Astrophysical Journal, 469: 355-365, September 20, 1996.

² On the Use of Empirical Bolometric Corrections for Stars, Guillermo Torres, The Astrophysical Journal, 140: 1158-1162, November 2010

Figure 1. Window for inputting data and displaying calculated values.

Star Name	INPUTS			OUTPUTS				Wikipedia Data			Percent Error		
	App. Mag.	Distance (LY)	BV Color	Abs Mag	Luminosity (Ls)	Temp. (K)	Radius (Rs)	Luminosity (Ls)	Temp. (K)	Radius (Rs)	(Ls)	Temp. (K)	(Rs)
Alpha Centauri A	0.01	4.37	0.71	4.37	1.52	5529.02	1.35	1.52	5790.00	1.22	-0.26%	4.51%	-9.98%
Bellatrix	1.64	250.00	-0.21	-2.78	1110.24	17854.56	3.48	9211.00	22000.00	5.75	87.95%	18.84%	39.43%
Betelgeuse	0.58	427.00	1.85	-5.01	8594.57	2763.04	404.59	90000.00	3590.00	887.00	90.45%	23.04%	54.39%
Deneb	1.25	2615.00	0.09	-8.27	173981.19	8573.93	189.02	196000.00	8525.00	203.00	11.23%	-0.57%	6.89%
Mintaka A	2.23	1200.00	-0.22	-5.60	14848.48	23846.50	7.14	190000.00	25600.00	6.50	92.19%	6.85%	-9.84%
Pollux	1.15	33.70	1.00	1.08	31.66	4843.87	7.99	43.00	4666.00	8.80	26.37%	-3.81%	9.20%
Regulus A	1.35	77.50	-0.11	-0.53	139.29	12008.16	2.73	288.00	12460.00	3.09	51.64%	3.63%	11.81%
Rigel	0.13	860.00	-0.03	-6.98	52769.07	11122.40	61.81	120000.00	12100.00	78.90	56.03%	8.08%	21.66%
Sirius A	-1.46	8.60	0.10	1.43	22.83	8454.18	2.23	25.40	9940.00	1.71	10.11%	14.95%	-30.22%
Sun	-26.74	0.000016	0.63	4.83	1.00	5785.46	1.00	1.00	5772.00	1.00	0.50%	-0.23%	0.50%
Tau Ceti	3.50	11.91	0.72	5.69	0.45	5499.48	0.74	0.52	5344.00	0.79	12.69%	-2.91%	6.43%

Table 1. Data and calculated values for selected stars.