Detailed Description of Project

Our project is a graphical simulation of a star. We originally set out to model a star through the use of equations that were to model the conditions of and within a star over time based on a starting mass. It took half of the time allotted to working on the projects before it became clear that the equations simply would not do as a result of their complexity and potential numerical instability. In our final product, a set of star data acquired from a website called EZ-Web was utilized. EZ-Web sends the star data in the form of a text file by e-mail, which is then imported into Mathematica as a “Table.” Some of these star data include radius, mass, temperature (surface and core), elemental composition (by mass and radius), etc…. From here, the lists are converted into associations, which allow for linking of a key (a word, symbol, phrase, etc…) to a particular list. The data lists describe the star at varying time points. These data lists are then turned into interpolating functions with respect to age (time), functions created by Mathematica to return approximate data describing the star at *any* point in time within the bounds of the data provided. To avoid odd behaviors when there were large jumps in time, the interpolating functions were set to create a function composed of lines that connect the data points. Using these interpolating functions, values could be produced for use in creating graphics for visualization of the star as it progresses through its lifetime.

Our original goal was to be able to manipulate the star through time and give it a starting mass. Both of these goals were accomplished. The exterior graphic shows the exterior of the star as a whole. The surface of the star changes color in response to its changing radius over the range of its maximum and minimum radii. We did not fully anticipate being able to make the star fade to white as it became a white dwarf (for 0.1 and 0.5 MSun stars) or show a planetary nebula at the end of the life of a 1 MSun star, but it was completed. Due to the wide range of sizes that a star can take, scaling functions had to be created to switch the PlotRange based on its current size, which will cause the star to sometimes look as if it has undergone major compression when it is simply a change of scale. Also included are a set of text readouts that give information about the mass, surface temperature, core temperature, radius, luminosity, and age at any point in the star’s life. Something else that was originally unanticipated but completed was a BarChart that expressed the elemental composition of the star by mass. Next, there is a core graphic that expresses the elemental composition of the star by radius. What was proposed was a single core graphic, whereas we ended up allowing the user to choose whether the core graphic was to be viewed on its own scale or on the scale of the star as a whole. The last graphic was an HR-diagram (Hertzsprung-Russell), which is a plot of luminosity vs surface temperature. This is widely used by astronomers to observe what stage the star is in its life. Our HR-diagram features a point representing the star which follows along a dashed path that represents its path from the start of the time frame to the end. The x-axis is reversed, and the y-axis is logarithmic to fit the formatting of HR-diagrams today.

We did not originally propose to include a user interface, but this has also been incorporated. It consists of a home screen that allows for the user to pick the starting mass. This then leads to a window where the user is able to set a lower and upper bound on the region of the star’s life being viewed. This information is then used to initialize the star and the simulation. It is important to note that many quantities are expressed as multiples of the sun’s properties. Throughout the entirety of our project, we have worked with Dr. Carini concerning the Astronomical/Astrophysical aspects of our project. We offered our project as a demonstration for future Astronomy classes that he would teach (granted that it accomplished what is supposed to), and he has recently (Reese, insert his decision here).