Project 1 Ideas

Objectives to Hit: Data Types, Loops/List, if/else statements, Dictionary

* Idea: Creating Data Table
  + Description: I was thinking maybe we can have them sort data, and have them create a table from them in the form of dictionaries. Like to get an objects RA and DEC for example we simply pass in something into the dictionary and it spits it out. Kinda like a catalog.
* Idea: Making a search algorithm where we can input astronomical objects and returns stuff about the objects, ex: coordinates, star type, galaxy type..
  + Description: I was thinking of maybe giving them information regarding stars and galaxies and have them work out a way to implement a search inquiry. That is, we provide them with data of all the objects of interest and it will be up to them to figure out the best way to configure the search inquiry. This will test out the students ability to run through loops and indexing as they will need to keep track of the correspondence of information and dictionaries will allow them to create a search inquiry where we pass in keywords and out comes the information. NOTE: I’m concerned that if we do this and we have multiple information about a star/galaxy then we might need to do a nested dictionary. Like object name, leads to star types etc.
* Idea: Object Finder
  + Description: Creating an app that helps finds the azimuth and alt of objects in the sky based on your location on earth. Alerts if stars are below the horizon/not visible. Maybe uses bay area landmarks to help guide person where to look.
  + I feel like this alone is not enough as a project, but I’m not really sure how to take it further.
* Idea: Game
  + Some Dice Rolling Game
  + Rock-Paper-Scissors
  + Code Breaker
    - they have to code up how to take input from the player, how to compare element wise, and compare unique elements, allow the player to guess again, and code the win condition
  + Hangman
* Projects stolen from that one website
  + <http://nifty.stanford.edu/2010/zingaro-song-generator/>
  + <http://nifty.stanford.edu/2019/stephenson-CodeCrusher/> (seems hard)
  + <http://nifty.stanford.edu/2010/neller-pig/> (this is the original hog project i think)

Project 2 Ideas

Objectives to Hit: project 1 objectives, class and objects, 1D array/plotting, File-io, 2D arrays/Plotting

* Idea: Projectile Motion
  + Description: Produce graphs of trajectories of projectiles given initial conditions.
  + Objectives: 1D array/plotting
* Idea: Space Invaders Game
  + Something something objects
* Idea: Use Data Set
  + Ideas for what data set to use:
    - Exoplanet stuff
  + 1-d array skills:
    - Taking the median/mean,, filtering and plotting the array
  + 2-D array skills
* Possible Data sets:
  + SDSS MaStar: MaNGA Stellar Library (MaStar) is a stellar spectral library with a wide coverage of stellar parameters, high quality calibration, and identical observing setup as the MaNGA survey.The spectra cover 3,622-10,354 Angstrom with a spectral resolution around R~2000. The final version will include approximately 10,000 stars. In DR15, we release the first version of the library containing 8646 good quality individual visit spectra for 3321 unique stars, which is only a subset of the final version.
    - <https://www.sdss.org/dr15/mastar/mastar-data-access/>
  + SDSS Data release 15: Data Release 15 includes six types of data: **images**, **optical spectra**(SDSS/SEGUE/BOSS/SEQUELS/eBOSS), **infrared spectra** (APOGEE/APOGEE-2), **IFU spectra** (MaNGA), **stellar library spectra** (MaStar), and **catalog data** (parameters measured from images and spectra, such as magnitudes and redshifts).
    - What can we do with the data?
      * Spectra allows us to use fitting methods, continuum subtraction is they have raw data.
      * Images allow plotting and manipulation of 2D arrays, not much we can do here. I know maybe there is photometry with 2D images we can do.
      * Stellar library spectrum can help us with some stellar models, can be used for a stellar final project.
  + Gaia Data: <https://www.cosmos.esa.int/web/gaia/dr2>
  + Gaia measures the positions, distances, space motions and many physical characteristics of some one billion stars in our Galaxy and beyond. For many years, the state of the art in celestial cartography has been the Schmidt surveys of Palomar and ESO, and their digitized counterparts. Gaia provides the detailed 3D distributions and space motions of all these stars, complete to 20th magnitude. The measurement precision, reaching a few millionths of a second of arc, is unprecedented. This allows our Galaxy to be mapped, for the first time, in three dimensions. Some 10 million stars will be measured with a distance accuracy of better than 1 percent; some 100 million to better than 10 percent.
  + Gaia's resulting scientific harvest is of almost inconceivable extent and implication. It will provide detailed information on stellar evolution and star formation in our Galaxy. It will clarify the origin and formation history of our Galaxy. The Gaia results will precisely identify relics of tidally-disrupted accretion debris, probe the distribution of dark matter and establish the luminosity function for pre-main sequence stars. They will also help to detect and categorize rapid evolutionary stellar phases, place unprecedented constraints on the age, internal structure and evolution of all stellar types, establish a rigorous distance scale framework throughout the Galaxy and beyond, and classify star formation and kinematical and dynamical behaviour within the Local Group of galaxies.
  + Gaia will pinpoint exotic objects in colossal and almost unimaginable numbers: many thousands of extra-solar planets will be discovered (from both their astrometric wobble and from photometric transits) and their detailed orbits and masses determined; tens of thousands of brown dwarfs and white dwarfs will be identified; thousands of extragalactic supernovae will be discovered; Solar System studies will receive a massive impetus through the observation of hundreds of thousands of minor planets; near-Earth objects, inner Trojans and even new trans-Neptunian objects, including Plutinos, may be discovered.
    - Maybe with this I was thinking we can make some predictions about what a patch of sky will look like after some time. It says above that they have the position and motion. Maybe we can tell students to look at a region of ra and dec and apply the motion of this over some time to find the new position. Don’t know if this is too simplistic though
    - Can do some exoplanets stuff here as it seems the last point says that extrasolar planets will be found using photometric transits.
  + TESS: <https://heasarc.gsfc.nasa.gov/docs/tess/data-access.html>
  + STSCI Data releases: <https://archive.stsci.edu/missions-and-data>

Final Project Ideas

Objectives to Hit: proj. 1, 2

* Idea: Radio Lab Sample
  + Description: I’m thinking that this lab can be two parts--a mixture of lab 1 and lab 4 (if we give them the data). Maybe we can motivate students by showing them what is possible with radio astronomy techniques (such as the black hole picture, maps of the Milky Way like in Lab 4). Then we get the power spectra, talk a little bit about fourier transforms and intensity, and show how this applies to mapping things?
  + Definitely hits all objectives, would probably require a lot of hand-holding and tutoring. I am confident in our ability to simplify things to its necessary parts though I think
* Idea: Stellar Project
  + Description 1:
  + Description 2: Another idea I was considering was actually more star based like looking at a spectrum of a star and maybe make some table of useful information like line flux, emission line ratios, etc.
* Idea: Planetary Project
  + Description: Modeling planetary orbits, requires a little bit of diff eq and differential equations.
  + Description: Perhaps for this one we can do something pertaining to exoplanets. Like maybe giving students some files and they have to tell us physical parameters of the star, the exoplanet. Something about its orbit
  + Idea: An Interface that Selects and Plots Photos of Neptune and Uranus
    - This idea is inspired by the research I did with Imke. My research was essentially just locating clouds on Neptune and Uranus. First I would get the “raw data” which was a picture of Neptune or Uranus, and then we would flatten the planet like one of those maps of the Earth and use the brightest pixel in the image array to find the center of the clouds in a specified region (I can get more pictures so it makes more sense). In any case, I created an interface that allowed me to select the data I wanted to process and reduce the data and locate the brightest cloud pixel, all through the terminal.
    - We wouldn’t do the actual reduction of the data, but probably have students pull from a folder of already reduced images. This would hit virtually everything that project 2 tries to cover, but with special emphasis to arrays, File.io, and 2-D plotting.
* Idea: Cosmology Project
  + Description:
* Idea: Data Reduction Project
  + Description: Essentially what i had to do this summer in Texas. If I get permission from my PI to use the raw data. I can give students 9 files of raw 2D spectra. The main part of this project is to:
    - 1. Find the ‘trace’: This is the spectrum that we are after. Student will need to come up with a way to find the trace in an automated fashion (ie: no hardcode)
    - 2. Once trace is found use surrounding sky to make a sky spectrum. This involves making a window from the trace and essentially removing it. You do not want the spectrum to be part of your sky measurement. And you check sky above the trace and belo.
    - 3. They need to come up with a criterion to check whether the sky changes a lot. But you want to check this with the closest sky spectrum to the trace because the sky can change drastically the farther away you go. If this happens they need to exclude this from further calculation
    - 4. Median the sky spectrums that they have found from above and below
    - 5. Subtract the sky from the raw 2D spectra
    - 6. Once sky is subtracted from every 2D spectra median combine them to get a clean image. This will get rid of cosmic rays.
    - 7. Lastly, extract a 1D galaxy spectra