Main Program:

1. Functions
   1. ???
2. Main
   1. Asks what someone want’s to generate, first indicated by a number from 1 to 4, then by name (possibly use or so we don’t lose functionality)

Objects:

1. Body
   1. Properties
      1. Name
         1. String, the name of the body, defaults to “Body”
      2. Mass
         1. The mass
         2. If python likes large numbers, go for it, otherwise, figure out a way to use sci notation, or assume it’s x10^6 Kg
      3. Radius
         1. The radius of the body
         2. In Km
      4. Density
         1. In whatever unit
         2. Density = mass/volume -> mass/(4/3) Pi \* radius
      5. Orbiting, single body
         1. OrbitedBy
         2. list, can be empty
         3. the body this orbits
      6. NumOrbiting
         1. Number of things orbiting this body
      7. Escape Velocity
         1. Square root ( mass / radius) <- still in terms of earth
      8. Surface Area
         1. 4 pi \* rad^2
      9. Volume
         1. 4/3 \* pi \* rad^3
      10. Is Orbited?
          1. Boolean indicating if the Orbited\_By list is empty
   2. Functions
      1. Functions to set all properties, properties are going to be private
      2. Unimplemented calc\_values functions, so each sub type can implement it
      3. Init with all properties specified
      4. Equals ?
      5. [Property]\_ToStr
         1. Prints out the value of a property with sci units at the end
      6. Add\_satilight
         1. Increments number of objects orbiting
         2. Appends to list of orbiting objects
   3. Constants (?)
      1. Moon Mass
      2. Moon Radius
      3. Sun’s surface temp
      4. Life time of sun
      5. Earth Gravity
      6. Earth escape velocity
2. Star
   1. Properties
      1. Classification
         1. O, >16x sun, blue
         2. G ~~sun, yellow
         3. M 0.02x sun, red
      2. Color
      3. Lifetime
         1. Roughly M^-3 in terms of sun, **or**  M in terms of sun / Luminosity in terms of sun, x life time of sun
      4. Habitable?
         1. Boolean, wheather a habitable planet is possible
         2. Mass roughly 0.6 to 1.4 times sun + orbit restrictions/habitable zone
      5. Luminosity
         1. Luminosity (in terms of sun) is roughly Solar Mass ^ 4
      6. Radius (inherited from Body Object)
         1. Radius is roughly Mass^0.74 (still in solar masses)
      7. Surface Temp
         1. Roughly equal to M^0.505 (still in terms of sun)
      8. Habitable Zone outer Limit
         1. 1.37 \* middle of habitable zone
      9. Habitable Zone inner Limit
         1. 0.95 \* middle of habitable zone
      10. Middle of the habitable zone:
          1. Distance from star = square root(Luminocity)
      11. Possible Planet Orbit Radii
          1. Set? Dictionary? List?, in AU
      12. Frost Line
          1. It’s a radius, after which gas giants form, accept for hot Jupiter’s
          2. Frost Line = 4.85 \* root(Luminocity, in terms of sun) AU
      13. Inner Limit
          1. Inner Limit = 0.1 \* M star, in terms of sun **or** 2.44 \* r \* cube root ( P planet/ P star)
      14. Outer Limit
          1. Outer limit = 40 \* M
   2. Functions
      1. Calc orbital distances (solar system like)
         1. First orbit, large gas giant = frost line + 1-1.2 Au
         2. Multiply the last orbit by a range of 1.4 to 2 to get the next farthest out till we reach the outer boundary
         3. Do the same for the inner boundary but dividing
         4. Make sure minimum separation of 0.15 AU between all orbits
      2. Calc Orbital Distances (Hot Jupiter)
         1. Choose distince the hot Jupiter is at
         2. If you want planets, make gap, then set the outer orbits
      3. Calc Orbital Distances (Frost Line)
         1. Note: contains large planets, greater than earth, less than Neptune. Also Tightly packed, mostly near frost line
         2. Make a few orbits near the frost line, maybe a few au in
         3. Purely because it should cluster a few, multiply the orbit by 0.8 – 0.95 a few times
         4. Then divide in half for the last few planets
         5. Add a gas giant **maybe, idk if these have them**
      4. Calc Orbital Distances (Long Period)
         1. Note: contains 2-4 large planets with long eccentric orbits
         2. Copy the solar system dividing from frost line, but allow for 1.1-1.9 variation, and only enough times to get the total desired planets
         3. Use those values for the closet approach, and find their mean distance eccentricity and other such info
      5. Calc Orbital Distances (Compact)
         1. 1.3-2.6 earth masses -> 1-3.5 earth mass for the planets. 4-7 planets? All closer than 1AU to the star
         2. **Important, need residences to work this out properly and stabley**
         3. Generation – add 0.05-1.15 AU to inner boundary point
         4. Choose number of planets
         5. Find resonant orbits based on the first orbit
      6. Set values to properties
      7. Is\_Habitable
         1. Checks to make sure acceptable mass range, and inner limit does not cover habitable zone
3. Star System
   1. Properties
      1. P-type
      2. S-type
      3. Number of stars (0-4)
         1. Can be stars or subsystems
         2. Total though should count subsystem star count
      4. Average Seperation
      5. Barry Center (in reference to star)
         1. Center of mass
         2. Barry Center = Average separation \* (Mass of star / average mass of the 2 suns)
      6. Eccentricity
      7. Max separation (From barry center)
         1. (1+eccentricity) X average separation
      8. Min separation (From barry center)
         1. (1-eccentricity) X average separation
      9. Max separation (from each other)
         1. 2 times max sep from barry center
      10. Min separation (from each other)
          1. 2 times min separation from barry center
      11. Forbidden Zone Inner Limit
          1. Closet to stars that can be orbited safely w/o instability
          2. Inner Limit = min separation / 3
      12. Forbidden zone outer limit
          1. Outer limit = max separation \* 3
   2. Functions
      1. Generate P-Type System (Tatooine)
         1. Generate the 2 stars
         2. Make sure the larger is between 0.1 solar masses and 16 solar masses
            1. 0.6 – 1.4 solar masses if looking for a habitable system
         3. Total values for the system from the 2 stars (eg mass, luminocity ect)
         4. Choose Average separation
            1. 0.15 – 6 AU
            2. Closer to 0.15 AU = more habitable
         5. Eccentricity
            1. 0.4-0.7 for best results
            2. Closer to 0.4 = more habitable
         6. Calc separations
            1. Check to make sure they never come closer than 0.1 AU, otherwise have to try again
         7. Calc Orbital Limits, frost line, and habitable zone like before
         8. Calc Forbidden zone
            1. Note, **if forcing habitability**, if this extends into habitable zone, should place our inner planet a little outside forbidden zone, especially if maximizing habitable planets

Just said must be at least 4x star minimum separation away … okay

* + - * 1. Outer edge must be within the outer orbital limit of the system, or restart
      1. Generate planet orbits like it’s a normal star from here on (see star orbit calculation functions)
    1. Generate S-Type system
       1. Generate stars
          1. Should both be within that 0.6-1.4 range this time (if we want both habitable), otherwise use the extended range
       2. Choose average separation
          1. 120-600 AU
          2. Farther apart = better
       3. Eccentricity
          1. 0.4-0.7 for best results
          2. Closer to 0.4 = more habitable
       4. Calc separations
       5. Note: both stars should have their inner and outer limits, and habitable zones calculated, so don’t need to find those here
       6. Check that the inner edge of the forbidden zone, 1/3 \* min separation still, is beyond the otter limit of both stars
       7. Calc orbits for both stars sepertly

1. Planet
   1. Inner planets are more likely to be rocky, and contain heavier materials
   2. Gas giants no closer than frost line
      1. Largest gas giant 1-1.2 au out from frost line ish maybe
   3. Properties
      1. Rotation speed
         1. Speed the planet spins on it’s \_\_\_\_ axis
      2. Axial Tilt (?)
      3. Density (inherited from body class)
         1. Terrestrial ~~ 3.5 (3.9 in video) – 5.5 (going to round up to 6) g/cm^3
         2. Overall, 0.92 – iron ??? 0.92 being ice
      4. Mass (inherited from body class)
         1. 0.1 -> 10 Earth masses = planet, terrestrial
         2. Gass giant = 10 \* earth mass -> 13 earth masses
      5. Radius (inherited from body class)
         1. Earth sized planets is M <= 1.25 \* Earth Radius
         2. Super Earth is 1.25 – 2 Earth Radi
         3. Neptune = 2-6
         4. Jupeter 6-15
         5. Larger Range from 0.0001 -> 0.1 Earth masses -> dwarf planets
      6. Gas giant
         1. Boolean, true = yes
      7. Tidally Locked
         1. Boolean
         2. If true, rotation speed will need to be generated more carefully
      8. Surface Gravity
         1. Gravity = mass/rad^2 = Rad \* density (relative to earth)
   4. Functions
      1. Generate Planet (terrestrial)
         1. Choose mass and radius from either the earth, or super earth range
            1. Note should be less than 1.6 \* earth radius
         2. Calc density
            1. Probably less than iron, but at least a little denser than water
         3. Check if density is terrestrial
      2. Generate Planet (gas giant)
         1. Choose mas from the range above
         2. Choose radius
            1. If >= 2 jupiter masses, radius = 1 jupiter radius
            2. If less than 2 jupter masses, radii can be bigger
         3. Calc density
         4. Check to make sure the density isn’t too high (less than water ice I guess, 0.92 g/cm^2)
         5. Calc other values
         6. (if a star is given choose an orbit beyond the frost line)
      3. Generate Planet (Puffy Giant)
         1. Choose a mass under 2 jupeter masses
         2. Choose a radius greater than Jupiter
            1. Max is 1.9 \* Jupiter
         3. Calc density, check to make sure the density is very low (going to say under 0.5 g/cm^3)
            1. **Absulte minimum is 0.03 g/cm^3** (not in reference to Jupiter densities or anything)
         4. Check the tidally locked box
         5. Calc other values
      4. Generate Planet (gasius dwarf)
         1. Choose a radius larger than 2 earth radii
         2. Chose a mass between 1 earth masses and 20 earth masses
         3. Check density to make sure it’s small, going to cap at 0.65 gm/cm^3
         4. (ORBIT should be fairly far out)
         5. Calc values
      5. Generate Habitable Planet
         1. Choose a mass (0.1 – 3.5 \* mass earth)
         2. Chose a radius (0.5 – 1.5 earth radii)
         3. Calc density/surface grav
         4. Check that surface grav is between 0.4 and 1.6 \* earth
         5. Check density is rocky, or at least an ocean world depending on goals
            1. If we can translate the graph in <https://www.youtube.com/watch?v=RxbIoIM_Uck&index=28&list=PLduA6tsl3gygXJbq_iQ_5h2yri4WL6zsS> from <https://youtu.be/bUPypOgNs_A?t=4m58s> then we should be able to mark if it’s rocky or water
2. Moon
3. Dwarf Planet (probably just a moon subclass)
   1. Properties
      1. Mass (from body via planet)
         1. Mass should Range from 0.0001 -> 0.1 Earth masses -> dwarf planets
         2. Safer range 0.03 Earth masses -> 0.1
      2. Radius (from body via planet)
         1. Should be > 0.03 earth radii
      3. Desnsity (via planet from body)
         1. Low -> ice
         2. Medium -> ice with some rock
         3. High -> rocky, maybe silicate core/iron core
   2. Functions
4. Orbit
   1. Properties
      1. Size
         1. ½ \* the total width/length, whichever is bigger
      2. Eccentricity
         1. 0 to 1, not inclusive
      3. Pitch
         1. The angle relative to the planets equatorial plane
         2. 0-180 degrees
      4. Longitude of the asending node/yaw
         1. Angle or distance or something from the reference line to the acending node
         2. 0-360 degrees
      5. Argument of peroapsis/roll
         1. Angle from acending node to periapsis
         2. 0-360 degrees
      6. True Anomoly/Plot
         1. Position of planet in it’s orbit relative to periapsis
         2. 0-360 degrees
         3. Probably not neccissary
   2. Functions

Versions:

1. Version 1
   1. Random Star/Planet/Moon generation
   2. Console interface
2. Version 2
   1. Add Random star system generation
3. Version 2.5
   1. Make a gui
4. Version 3
   1. Add ability to specify details of generation
      1. Specific luminocity star
      2. Specify rocky or gas
      3. Moon mas, or radius ?
      4. Number of stars in a star system
   2. Set up the ability to have bodies orbit other bodies, and be orbited by bodies
5. Version 4
   1. Add the ability to force generate a star with a habitable planet
   2. ? generate a star with the maximum number of habitable planets, and force them to be habitable ?
   3. Implement version 3 and 4 features for gui
6. Version 5
   1. Add the ability to create custom stuff, by specifying all details
   2. Be able to generate or calculate stuff people don’t want to during this process
   3. Add this to gui
7. Version 6?
   1. Non main sequence stars?
   2. Black holes?
   3. Asteroid belts?
   4. Dwarf stars?

Other Notes:

Hot jupter, F/G type stars, maybe K

Mass is close to or greater than Jupiter, Less dense than Jupiter

Tidally locked, minimal moons (maybe 0.1 AU)

Max distance is 0.15 AU (????)

Probably retrograde relative to star

<2 Juppiter masses -> puffy giant sometimes, much larger radius, closer to sun, 0.04 AU< orbit < 0.15

Eccentricity greater than 0.1 -> excentric Jupiter

Gas dwarf not v dense, 2x mass earth, far away from star

Super jupeter, (almost up to 13 \* jupeter masses, 13 is the hard limit)

Other sanity checks –

Core pressure should have liquid iron, or other metals, check the pressure of the planet from center to the edge of the core and check that it’s still has some liquid iron.

Pressure core = 2/3 pi density^2 G R planet^2

Alternatively

Integrate from 0 to Rplanet, on 4/3 pi r density( r ) G dr

= 4/3 pi G \* integral from 0 R( density ( r ), r dr

If the rotation speed would tear the planet apart, see homework 1 from astronomy 315