Science Assignment 6: Drake’s equation as a working document
American astronomer Frank Drake is credited with coming up with “the” equation of extraterrestrial contact. In 1961, he was working on Project Ozma for the National Radio Astronomy Observatory at Green Bank, West Virginia. The project was simple: set a radiotelescope to receive signals at a particular frequency, point it at a star likely to have planets around it with civilizations like ours, and listen.

He quickly encountered the difficulty of knowing what “likely” meant, so he organized a conference in which he presented the first version of the equation:

\[ N = R^* \cdot f_{\text{planet}} \cdot n_e \cdot f_{\text{life}} \cdot f_{\text{intelligence}} \cdot f_{\text{civilization}} \cdot L \]

where \( N \) is the number of transmitting civilizations in our galaxy, \( R^* \) is the galactic birthrate of stars suitable for hosting life, \( f_{\text{planet}} \) is the fraction of such stars having planets, \( n_e \) is the number of planets per solar system that have an environment favorable for life, \( f_{\text{life}} \) is the fraction of such planets on which life actually evolved, \( f_{\text{intelligence}} \) is the fraction of inhabited worlds that develop intelligent life, \( f_{\text{civilization}} \) is the fraction of planets having intelligent beings that produce a civilization capable of interstellar communications and \( L \) is the lifetime that such civilizations will actually be broadcasting.

The terms in the equation above are daunting, so let’s try an analogy much more down-to-earth: estimating the number of students at North who can have a meaningful conversation about sentence diagramming. That topic is covered in ENG 104 and we’ll try to figure out that number of students from readily obtainable data.

Procedure:
Form into small groups, and obtain a course schedule for next quarter.

First, make \( N \) (as in the Drake Equation) the target number; in our case, it will be the number of students at North who can have a meaningful conversation about sentence diagramming. Since those students are going to be exclusively from having taken ENG 104, let’s start by figuring out how many courses North has ever offered. The document below is from a Seattle Community College District quarterly report for North.

<table>
<thead>
<tr>
<th>ADMIN UNIT</th>
<th>TITLE</th>
<th>CLASSES</th>
<th>CAPACITY</th>
<th>ENROLLMENT</th>
<th>OPENINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLLEGE TOTAL</td>
<td>1,380</td>
<td>31,467</td>
<td>16,505</td>
<td>17,215</td>
<td></td>
</tr>
</tbody>
</table>

1. Take the appropriate number from the document, which is for one quarter, then multiply it by the number of quarters in a North academic year; you may discount summer quarter. Show your calculation below and call it \( R_{\text{courses}} \)
2. Now, let’s start narrowing down the number of courses. About what fraction of all courses at North are English department courses? You could count each individual course in the schedule, but an easy way to do it is to determine how many pages of the schedule English department courses cover, divided by the total number of course description pages in the schedule (you may discount the Continuing Education pages). Write the fraction below (don’t turn it into a decimal) and call it $f_{\text{English}}$.

3. Next, of the English courses, what fraction are ENG 104? This can be done by a strict count; count each section (even if they are for the same course) separately and write the fraction below. Call it $f_{104}$.

4. Next, determine how many students would enroll in a section of ENG 104; all of you have had ENG 101 classes and so can estimate the number of students enrolled in a typical English class. Call this number (notice that this is not a fraction) $N_{\text{students}}$.

5. Next, to have a meaningful conversation about sentence diagramming, we should make the assumption that these students received a passing grade in ENG 104. Notice that you could probably fail ENG 104 and understand sentence diagramming perfectly, but we have to make an assumption otherwise the calculation is impossible. Estimate the fraction of students that pass an English course and call it $f_{\text{pass}}$.

6. Finally, we make the assumption that sentence diagramming is esoteric enough that a typical student forgets how to do it or what it’s for soon after they leave North. We therefore need to estimate the length (in years) of a typical student’s career at North. Write your best guess down and call this number L.

7. Let’s put all the letters together. Write the equation for N (the number of students at North who can have a meaningful conversation about sentence diagramming) using only the letters (no numbers) used in the questions above. What arithmetic operation is going to connect all of the terms in the equation?
8. Go ahead and use the numbers you determined and get a **numerical value** for N. Does N seem too high, too low or about right? What makes you think so?

9. Hold on. Ask around the room and find out what numbers other groups got for the answers to questions 4, 5 and 6. Write the **highest** and **lowest** values for each of those answers below.

   **Question 4**
   - Highest: 
   - Lowest: 

   **Question 5**
   - Highest: 
   - Lowest: 

   **Question 6**
   - Highest: 
   - Lowest: 

10. Finally, use only the **highest** values for those questions and determine the highest value for N possible. Then use only the **lowest** values for those questions and determine the lowest value for N possible. Do either of those extreme values seem more reasonable to you?

11. Pick **one other value** you determined that, in retrospect, might not be reasonable (not question 4, 5 or 6). What assumption(s) did you make when figuring out the value for that particular number? How would you change it (higher? lower?), and how would that affect N ultimately (higher? lower)?

Now, reread the discussion on pages 192 to 195 of Ward and Brownlee, and appreciate the difficulty of estimating **any** of the numbers in the **real Drake Equation**.