1. **Programming**
2. What are the names and integer positions of the columns? Save as colname\_index.txt List the last three here:

*tail -n 3 column\_index.txt*

59. *awarding\_subtier\_agency\_abbreviation*

60. *funding\_subtier\_agency\_abbreviation*

61. *business\_categories*

1. How many characters are in the longest line? Save as maxchars.txt.

There are 7031 characters in the longest line.

1. Find all the rows in the data where the string bicycle appears. Use a case insensitive match. Save as bicycle.csv. How many are there?

There are 32122 lines that match the string “bicycle” (case insensitive) in this database.

1. Find the set of unique funding agencies, meaning no duplicates. Save as funding\_agency\_set.txt. How many are there?

There are 781 unique funding agency IDs (780 if not counting blank entries as a unique funding agency ID).

1. Find the description (transaction\_description) and amount (total\_obligation) of the 3 largest transactions. Save as largest.csv. List them here.
2. Amount: $3400000
   1. Description: *6250007 OSCE SMM UKRAINE 2017-2018 EXB CONTRIBUTION ASSESSED VOLUNTARY*
3. Amount: $820500
   1. Description: *3200375 ENHANCING CYBERSECURITY AND TRANSPARENCY OF ELECTION PROCESSES IN UKRAINE*
4. Amount: $559300
   1. Description*: 1100764 PCU CHEMICAL SECURITY RESPONSE TEAM*
5. **Reflecting**

1. Explain in your own words the sbatch submission process. Start with moving code to the cluster, and finish with downloading a result.

The sbatch submission progress begins with downloading code through cloning a repository via github or direct movement of files through a transfer protocol such as SSH file transfer protocol (SFTP). The latter is better capable of handling larger files but lacks the convenience of a downloadable repository. After code has been moved to the cluster, initiation of a shell script using *sbatch* requests that the head node queue and assign processing tasks to worker nodes within the cluster. Depending on size of the task, general cluster demand, and task organization (such as number of nodes used in parallel tasks), the worker node completes the specified task, producing an output summary and associated products of the shell script. These are stored within the cluster and can then be accessed locally, either by pushing changes to a remote github repository or directly downloading files from the remote machine to a local directory using SFTP.

2. Are the funding agency ID’s in this assignment the same as in the first data set?

3. These two bash commands will produce the same output. Which is more efficient, and why?

1. cat file | sort | grep "pattern"  
2. cat file | grep "pattern" | sort

The latter will be more efficient, as the *grep “pattern”* command will reduce the size of the object being accessed during the sort. As the order of these operations can be performed interchangeably, first subsetting the object to rows which contain the pattern then sorting will be far faster than sorting over all entries (including those that do not contain the pattern) then searching for the pattern amongst all the pre-sorted entries.

4. Come up with your own question about this data set that you can answer with a single sequence of bash commands as you did with the questions in the first section. Run it and verify that it does what you expect. Show your code and explain what every step does