P5 Analysis

threeletterwords.txt:

```
init time: 0.003435     for BruteAutocomplete
init time: 0.005393     for BinarySearchAutocomplete
init time: 0.1360       for HashListAutocomplete
init time: 0.002709     for SlowBruteAutocomplete
search          size    #match          BruteAutoc      BinarySear      HashListAu      SlowBruteA
                17576   50              0.00278283      0.00311952      0.01498799      0.01497152
                17576   50              0.00213220      0.00242699      0.00090511      0.00289755
a               676     50              0.00039683      0.00018401      0.00006650      0.00147742
a               676     50              0.00036991      0.00014406      0.00000741      0.00161029
b               676     50              0.00033945      0.00014296      0.00000628      0.00064667
c               676     50              0.00030653      0.00013767      0.00000544      0.00053573
g               676     50              0.00031171      0.00013290      0.00000575      0.00049261
ga              26      50              0.00043081      0.00003276      0.00000867      0.00144885
go              26      50              0.00034582      0.00002497      0.00000634      0.00063166
gu              26      50              0.00031088      0.00002231      0.00000589      0.00052792
x               676     50              0.00019046      0.00013812      0.00000523      0.00049304
y               676     50              0.00015425      0.00012539      0.00000498      0.00046397
z               676     50              0.00013678      0.00011565      0.00000369      0.00042419
aa              26      50              0.00010317      0.00001558      0.00000381      0.00034966
az              26      50              0.00013548      0.00001398      0.00000343      0.00034050
za              26      50              0.00013172      0.00003309      0.00000366      0.00037399
zz              26      50              0.00009393      0.00001377      0.00000319      0.00033506
zqzqwwx         0       50              0.00006639      0.00009605      0.00000194      0.00027151
size in bytes=246064  for BruteAutocomplete
size in bytes=246064  for BinarySearchAutocomplete
size in bytes=354276  for HashListAutocomplete
size in bytes=246064  for SlowBruteAutocomplete
```

fourletterwords.txt:

```
init time: 0.04802      for BruteAutocomplete
init time: 0.02578      for BinarySearchAutocomplete
init time: 0.9846       for HashListAutocomplete
init time: 0.06286      for SlowBruteAutocomplete
search          size            #matchBruteAutoc        BinarySear      HashListAu      SlowBruteA
                456976          50      0.01241406      0.01836478      0.41421654      0.29288930
                456976          50      0.00667562      0.00642832      0.01478244      0.09906331
a               17576           50      0.00895730      0.00045006      0.00006628      0.08993487
a               17576           50      0.00616308      0.00024541      0.00000831      0.01881886
b               17576           50      0.00540726      0.00019800      0.00000826      0.02011829
c               17576           50      0.00694462      0.00021048      0.00000978      0.02636356
g               17576           50      0.00631954      0.00022321      0.00000917      0.02078886
ga              676             50      0.00543660      0.00005692      0.00000932      0.06598309
go              676             50      0.00543206      0.00005346      0.00000876      0.02558300
gu              676             50      0.00612399      0.00005926      0.00000862      0.02309128
x               17576           50      0.00548320      0.00019447      0.00000846      0.02363984
y               17576           50      0.00480503      0.00013822      0.00000817      0.02487011
z               17576           50      0.00440203      0.00013148      0.00000770      0.01788699
aa              676             50      0.00524679      0.00004194      0.00000774      0.01975342
az              676             50      0.00440608      0.00004196      0.00000800      0.01786060
za              676             50      0.00441130      0.00003769      0.00000825      0.01791210
zz              676             50      0.00431384      0.00003626      0.00000788      0.01753162
zqzqwwx         0               50      0.00399646      0.00015594      0.00000410      0.01514425
size in bytes=7311616           for BruteAutocomplete
size in bytes=7311616           for BinarySearchAutocomplete
size in bytes=11075636          for HashListAutocomplete
size in bytes=7311616           for SlowBruteAutocomplete
```

alexa.txt

```
init time: 0.3980        for BruteAutocomplete
init time: 1.277         for BinarySearchAutocomplete
init time: 18.43         for HashListAutocomplete
init time: 0.2464        for SlowBruteAutocomplete
search size              #matchBruteAutoc   BinarySear   HashListAu   SlowBruteA
         1000000         50    0.02877411   0.02601620   0.84307999   0.05793810
         1000000         50    0.02083079   0.00688700   0.02529784   0.05945781
a        69464           50    0.01649667   0.00057055   0.00008403   0.09325157
a        69464           50    0.01510143   0.00052555   0.00000933   0.01971569
b        56037           50    0.01479283   0.00046560   0.00000937   0.01907058
c        65842           50    0.01525077   0.00047035   0.00000916   0.02009021
g        37792           50    0.01460311   0.00031984   0.00000916   0.01855022
ga       6664            50    0.01677801   0.00013166   0.00000929   0.02004014
go       6953            50    0.01435484   0.00012815   0.00000860   0.01633872
gu       2782            50    0.01480936   0.00009008   0.00000902   0.01678636
x        6717            50    0.01458573   0.00012171   0.00000890   0.01639074
y        16765           50    0.01532356   0.00019520   0.00000973   0.01743954
z        8780            50    0.01663051   0.00015496   0.00001174   0.02021598
aa       718             50    0.01727031   0.00005650   0.00001073   0.01857138
az       889             50    0.01487799   0.00005836   0.00001014   0.01671815
za       1718            50    0.01415889   0.00007614   0.00001024   0.01805918
zz       162             50    0.01633479   0.00004039   0.00001121   0.01890993
zqzqwwx       0          50    0.01462145   0.00010380   0.00000468   0.01682340
size in bytes=38204230        for BruteAutocomplete
size in bytes=38204230        for BinarySearchAutocomplete
size in bytes=98824414        for HashListAutocomplete
size in bytes=38204230        for SlowBruteAutocomplete
```

alexa.txt with 10000 matches

```
init time: 0.3985       for BruteAutocomplete
init time: 1.202        for BinarySearchAutocomplete
init time: 18.32        for HashListAutocomplete
init time: 0.2396       for SlowBruteAutocomplete
search size             #match          BruteAutoc      BinarySear      HashListAu      SlowBruteA
        1000000         10000           0.04014264      0.06081970      0.82038883      0.06577187
        1000000         10000           0.02909527      0.04821138      0.02431451      0.06201255
a       69464           10000           0.02178898      0.01679692      0.00007598      0.09220968
a       69464           10000           0.02495816      0.01850620      0.00001097      0.02510543
b       56037           10000           0.02611136      0.01687008      0.00001066      0.02319870
c       65842           10000           0.02220133      0.01704891      0.00000945      0.02050454
g       37792           10000           0.02479252      0.01362825      0.00000977      0.02171189
ga      6664            10000           0.02179015      0.00318720      0.00000921      0.01785089
go      6953            10000           0.02576133      0.00412738      0.00001188      0.02227607
gu      2782            10000           0.01963187      0.00144085      0.00001029      0.01909701
x       6717            10000           0.01961091      0.00335890      0.00001136      0.01727148
y       16765           10000           0.02208598      0.00854146      0.00001175      0.02009547
z       8780            10000           0.02640615      0.00512763      0.00001077      0.01961767
aa      718             10000           0.01622289      0.00027748      0.00001032      0.01790530
az      889             10000           0.01606981      0.00035364      0.00001045      0.01755411
za      1718            10000           0.01833839      0.00080624      0.00001207      0.02060852
zz      162             10000           0.01727349      0.00006181      0.00001192      0.02071385
zqzqwwx         0       10000           0.01687941      0.00011003      0.00000549      0.01787352
size in bytes=38204230          for BruteAutocomplete
size in bytes=38204230          for BinarySearchAutocomplete
size in bytes=98824414          for HashListAutocomplete
size in bytes=38204230          for SlowBruteAutocomplete
```

The #match affects BinarySearchAutocomplete and BruteAutoComplete the most because maintaining a PriorityQueue that has the first k best matches is an O(logk) operation, and returning the top k matches from a PriorityQueue is an O(k) operation.

#match does not affect the runtime of HashListAutocomplete because all search results are already stored in a HashMap at init, and getting a list from a HashMap is an O(1) operation.

#match also does not affect SlowBruteAutocomplete as much because it will always sort through the list of all possible matches, then return the top k.

3. Explain why the last for loop in BruteAutocomplete.topMatches uses a LinkedList (and not an ArrayList) AND why the PriorityQueue uses Comparator.comparing(Term::getWeight) to get the top k heaviest matches.

For a LinkedList, there is the possibility of addFirst(), which is important for fransferring elements in reverse order from a PriorityQueue because the lowest valued element always gets removed first. Therefore, we always want to be adding each successive element before the first element in the LinkedList to ensure that larger values come first.

The PriorityQueue compares elements in order to determine what order they come it. Therefore, Term::getWeight tells the PriorityQueue to sort the terms by their weights instead of the default, which is probably their string values.

4. Explain why HashListAutocomplete uses more memory than the other Autocomplete implementations. Be brief.

In order to achieve O(1) runtime in finding the top k matches, the method goes through every possible search at init and stores all the possible results in a HashMap. This uses more memory than other methods, which only create the list of results of one single search.