Purpose

You’ve probably learned about mergesort in the context of arrays. However, consider for a moment the core part of the mergesort algorithm: the merge operation. This operation scans through two sequences of items linearly; it doesn’t require the random access capabilities of an array. So, mergesort is actually a good algorithm for sorting lists. In fact, it’s even better for linked lists than arrays, since it can merge two parts of a linked list in place — without requiring extra storage.

Mergesort for Linked Lists

Mergesort takes an input list and treats it as though it were a collection of small sorted lists. It makes log $N$ passes along the list, and in each pass it combines each adjacent pair of small sorted lists into one larger sorted list. When a pass only needs to do this once, the whole output list is sorted.

Require: $L$ is a singly linked list of length $N$

Ensure: Upon return, $L$ is sorted from low to high

repeat
  $k = 1$
  Set pointer $p$ to point to the head of $L$
  Let $T$ be an empty temporary list
  Set number of merges to zero
  while $p \neq$ NULL do
    Increment number of merges
    Set pointer $q = p$
    Step $q$ along the list $k$ items (or until end of list)
    Set $psize$ to number of items skipped
    $qsize = k$ {Merge a list of length $psize$, starting at $p$, with a list of at most $qsize$, starting at $q$}
    while $psize > 0$ or ($qsize > 0$ and $q \neq$ NULL) do
      if one list is empty then
        Set pointer $e$ to the item from the non-empty list
      else
        Set pointer $e$ to the smaller of the current items in the two lists
      end if
      Remove $e$ from the list, advancing either $p$ or $q$ and decrementing either $psize$ or $qsize$
      Add $e$ to the end of list $T$
    end while{We have merged the $p$ and $q$ lists}
  end while
  $L = T$
  $k = k \times 2$ {We’ve merged all lists of length $k$}
  until number of merges equals 1

As you can see, this is the same mergesort algorithm we learned in class, except that it is operating on a linked list and it is implemented iteratively (by starting with lists of size 1 and building up). Note that, while the array based mergesort requires $\Theta(N)$ extra memory, the linked list based one only requires $\Theta(1)$, because moving items from one list to another in the merge also moves their storage.
Statement of Work

Write a program to perform a mergesort on a linked list, using a linked list class of your own design with a `mergeSort()` method. To test your algorithm, your program should create a linked list object and initialize it by reading integers, one per line, from a file named `input.txt`. Some sample input files (that contain random sequences of unique integers) are provided. Please have your program output the full contents of the final sorted list to a file `output.txt`. 