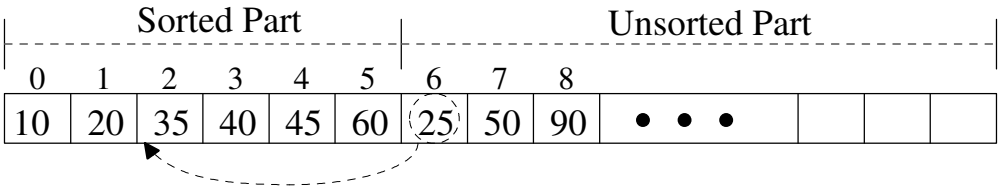
Data Structures (CS 1520) Homework #5 Due: 11/7/15 (Sat) at 11:59 PM

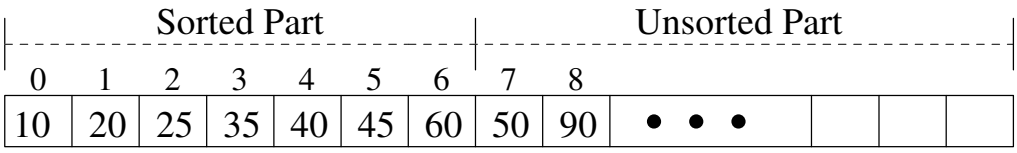
Objective: Become more proficient at implementing sorting algorithms.

Start by downloading: `hw5.zip` from http://www.cs.uni.edu/~fienup/cs1520f15/homework/

Part A: Recall that after several iterations of insertion sort's outer loop, a list might look like:



In insertion sort the inner-loop takes the "first unsorted item" (25 at index 6 in the above example) and "inserts" it into the sorted part of the list "at the correct spot." After 25 is inserted into the sorted part, the list would look like:



Code for insertion sort discussed in class is given below:

```
def insertionSort(myList):
    """Rearranges the items in myList so they are in ascending order"""

    for firstUnsortedIndex in range(1,len(myList)):
        itemToInsert = myList[firstUnsortedIndex]

        testIndex = firstUnsortedIndex - 1

        while testIndex >= 0 and myList[testIndex] > itemToInsert:
            myList[testIndex+1] = myList[testIndex]
            testIndex = testIndex - 1

        # Insert the itemToInsert at the correct spot
        myList[testIndex + 1] = itemToInsert
```

The inner-loop combines finding the correct spot to insert with making room to insert by scanning the sorted part from right-to-left and shifting items right one spot to make room until the correct insertion spot is found.

For Part A, I want you to decouple the finding of the correct spot from making room by:

- finding the right spot in the sorted part for the item to be inserted by doing a binary-search of the sorted part, then
- make room to insert at the right spot

Compare the performance of your code with the original insertion sort on "large" random integer arrays. Turn in a timing comparison between your code and the original insertion sort.

Part B: The advanced sorts like merge sort ($O(n \log_2 n)$ in the worst-case) are faster than the simple sorts ($O(n^2)$) when n is large, but the simple sorts are actually faster when n is "small". Use the `hw5/compareSorts.py` program to experimenting determine the threshold of when the selection sort (a simple sort) is faster on randomly ordered lists than merge sort on your computer. THEN, implement an improved merge sort that utilizes selection sort on small (i.e., less than your threshold) length lists. See the picture on the backside of this handout. In addition to your code, include a report of the timing improvement of your improved merge sort over the original merge sort from lab 8.

SUBMISSION

Submit **ALL necessary files** to run your sorts and your timing "reports" for parts A and B as a single zipped file (called hw5.zip) electronically at

https://www.cs.uni.edu/~schafer/submit/which_course.cgi

Diagram illustrating Part B of the assignment: