Ivy Truong

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Algorithms HW2 Pt3

Loop Invariant for Merge Sort

1. Loop invariant means a condition that proves true before and after the iteration in a loop.
2. The loop invariant in my merge function is when the length of the left subarray is not zero and the length of the right subarray is not zero. While being sorted, the left or right subarray decreases in length by 1 when the smallest value in the subarray is sorted into the new larger array. The new array should have all the elements sorted together.
3. The initialization step is that the subarrays contain at least 1 element in the array and the new larger array is sorted. In the dividing part of the merge sort, the original unsorted array is continually divided in half until the size of each subarray is 1 before starting its first merge between the two subarrays. Before the merging starts, the new larger array initially has a size of zero, so technically the array is sorted because there are no values in the array.
4. In the maintenance step, we assume that the initial step in the loop invariant is true. In the loop, the first two if statements compare the smallest values between the two subarrays and the smallest one out of both of them is appended to the new array. After the smallest value in the subarray is appended to the new array, it is removed from the subarray and will allow the loop to compare the next smallest value in that subarray in the next iteration. The second set of if statements checks if one of the subarrays is empty, and if it is then it appends the rest of the values in that subarray to the new larger array. The new array will consist of the values from the two smaller subarrays, but in sorted order. This new larger array will be passed and compared to another subarray and start the process again. This preserves the loop invariant by comparing the smallest values of both subarrays and sorting it until both the left and right subarrays are empty.
5. The termination step is when the length of the left subarray or the length of the right subarray are zero, showing that all the values in each subarray have been sorted into the new larger array and that the algorithm is correct. For example, if the left subarray is zero, the second set of if statements will append the rest of the values in the right subarray to the new array before being compared to the while loop condition and ending it.