ECE 130 - INDUCTION AND RECURSION - INVESTIGATION 11
RECURSIVE SORTING ALGORITHMS

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To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include appropriate graphs and tables.

The objective of this Investigation is to introduce recursive sorting algorithms for putting data in a desired form like numerical or alphabetic order. The basic idea of these algorithms is divide and conquer as follows

(1) First the problem is **divided** into smaller subproblems
(2) Then the smaller subparts are **conquered** recursively
(3) And finally the results from the subparts are combined

1. We begin with **selection sort**. Suppose we want to put a list of numbers like the following

   6 3 2 5 1 7 9 8

   into numerical order from the smallest to the largest

   (1) First go through the list of numbers to find the smallest and then exchange it with the first number to give us

   1 3 2 5 6 7 9 8

   (2) Then repeat until all the numbers are in order

   a. Show all the steps in a selection sort of the following numbers

   1 0 2 9 8 7 3 5

   b. What makes this algorithm recursive
   c. Write pseudocode to implement a recursive algorithm SelectionSort (L, j-1) to sort a list of numbers of length L

2. The objective of this problem is to introduce **merge sort**. Suppose we want to put a list of numbers like the following

   6 3 2 5 1 7 9 8

   into numerical order from the smallest to the largest

   (1) First pair the numbers in groups of two as follows

   6 3 2 5 1 7 9 8

   and then order them as follows

   3 6 2 5 1 7 8 9

   (2) We now **merge** the groups of two's into groups of four as follows

   2 3 5 6 1 7 8 9

(3) And so on until the numbers are all in order

a. Do a merge sort of the following numbers

1 0 2 9 8 7 3 5

from smallest to largest. Show each step

b. Repeat part (a) for the following numbers

8 5 3 4 2 1 9 7

c. What makes merge sort a recursive algorithm

d. Write pseudocode for merge sort

3. The objective of this problem is to introduce the binary search algorithm for finding elements in a data set. Suppose, in particular, we want to determine if the number 12 is in a given list of numbers. One way of course is to simply start at the beginning of the list and check every data point until we find what we're looking for or exhaust the list. But if the list is in numerical order as follows

x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
2	4	7	8	9	10	12	14

we can make use of **binary search** to more efficiently find out if 12 is present as follows

(1) Divide the numbers in half and then make use of the fact that $12 > 8$ to determine that 12, if present, would be in the group x_5, x_6, x_7, x_8

(2) Make use of the fact that $12 < 15$ to conclude that if 12 is in the sequence then it must equal x_4

a. Make use of the binary search to determine if 23 is in the sequence

5 7 8 12 15 20

Show all the steps

b. What makes binary search a recursive algorithm