ECE 130 - INTRODUCTION TO ALGORITHMS - INVEST 5
INTRODUCTION TO SEARCHING AND 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.

In the first four Investigations we reviewed set theory and basic methods for doing proofs. The objective of this Investigation is to introduce what algorithms are by looking at some examples. In particular we'll be looking at algorithms for searching and sorting of data.

1. We begin with the **linear search algorithm** for determining if a number N is in a sequence of numbers as follows

$$S = \{s_1, s_2, \cdots, s_M\}$$

The linear search algorithm begins by first seeing if $N = s_1$. If it is then we're done. If not we check to see if $N = s_2$ and so on.

   a. Write out the result of each comparison as you go through the algorithm to see if N=5 is in the set $S = \{3,8,4,5,9,2\}$
   b. Write a flowchart for the algorithm
   c. Do an example to test your flowchart - write down the result of every comparison

2. In the last problem we were searching for a number N in a general sequence. The objective of this problem is to introduce the **binary search algorithm** - an algorithm for determing if a number N is in a sequence of numbers S that is in numerical order. The basic idea of binary search for N=5 in a sequence like $S = \{3,8,4,5,9,2\}$ is to compare N to the number in the "middle" - in this case $s_3 = 4$ and see if $N = 4$, $N < 4$ or $N > 4$. Since $N > 4$ we repeat the process in the upper half of the sequence. And then continue until we find N or find that N is not present.

   a. Write out the result of each comparison as you go through the algorithm to see if N=5 is in the set $S = \{3,8,4,5,9,2\}$
   b. Write a flowchart for the algorithm
   c. Do an example to test your flowchart - write down the result of every comparison

3. The first two problems introduced searching algorithms. Now we'll introduce two sorting algorithms. The objective of this problem is to introduce the **bubble sort algorithm** for putting numbers in numerical order from lowest to highest. The idea is to take a sequence as follows

$$S = \{s_1, s_2, s_3, s_4, s_5\}$$

and first compare s_1 and s_2 and reverse them if $s_1 > s_2$ and then compare the new s_2 with s_3 and reverse them if $s_2 > s_3$ and so on all the way up the line. And then redo the process starting from the beginning until there are no more switches

   a. Write out the result of each comparison as you go through the bubble sort algorithm to put the set of numbers $S = \{3,8,4,5,9,2\}$ in numerical order from lowest to highest
   b. Write a flowchart for the algorithm
   c. Do an example to test your flowchart - write down the result of every comparison

d. Why do we call this a bubble sort

4. The objective of this problem is to introduce the **insertion sort algorithm** for putting numbers in numerical order from lowest to highest. Given the sequence $S = \{s_1, s_2, s_3, s_4, s_5\}$ we start with s_1 and then "insert" s_2 before or after s_1 depending on which is larger. We then insert s_3 and so on
    a. Write out the result of each comparison as you go through the insertion algorithm to put the set of numbers $S = \{3,8,4,5,9,2\}$ in numerical order from lowest to highest
    b. Write a flowchart for the algorithm
    c. Do an example to test your flowchart - write down the result of every comparison

5. What, in your own words, are algorithms