Name:_____

1. The following is the textbook's code for a *linear search* on an unsorted array.

```
//*****************************************************************
// The searchList function performs a linear search on an         *
// integer array. The array list, which has a maximum of numElems *
// elements, is searched for the number stored in value. If the   *
// number is found, its array subscript is returned. Otherwise,   *
// -1 is returned indicating the value was not in the array.      *
//*****************************************************************

int searchList(int list[], int numElems, int value) {
   int index = 0;        // Used as a subscript to search array
   int position = -1;    // To record position of search value
   bool found = false;   // Flag to indicate if the value was found

   while (index < numElems && !found) {

      if (list[index] == value) { // If the value is found
         found = true;            // Set the flag
         position = index;        // Record the value's subscript
      } // end if

      index++;                    // Go to the next element
   } // end while

   return position;               // Return the position, or -1
} // end searchList
```

a) Trace the `searchList` code using the following data.

	0	1	2	3	4	5	6	(MAX-1)
list:	3	9	5	7	8	2	4	

numElems: 7 value: 2

b) If numElems is 1,000,000, then how many comparisons of array items would you **expect** on a *successful search*?

c) If numElems is 1,000,000, then what is the maximun number of comparisons of array items on a *successful search*?

d) If numElems is 1,000,000, then how many comparisons of array items would you expect on an *unsuccessful search*?

e) If there are 1,000,000 names in a phone book, what algorithm do you use to search for a name, say "Smith, John".

Name:_____

2. The following is the textbook's code for a *binary search* on an array sorted in *ascending order* (items get bigger as we go from left to right).

```
//*************************************************************
// The binarySearch function performs a binary search on an     *
// integer array. array, which has a maximum of size elements,  *
// is searched for the number stored in value. If the number is *
// found, its array subscript is returned. Otherwise, -1 is     *
// returned indicating the value was not in the array.          *
//*************************************************************

int binarySearch(int array[], int size, int value) {
   int first = 0,              // First array element
       last = size - 1,        // Last array element
       middle,                 // Mid point of search
       position = -1;          // Position of search value
   bool found = false;         // Flag

   while (!found && first <= last) {
      middle = (first + last) / 2;     // Calculate mid point
      if (array[middle] == value) {    // If value is found at mid
         found = true;
         position = middle;
      } else if (array[middle] > value)  // If value is in lower half
         last = middle - 1;
      } else {
         first = middle + 1;           // If value is in upper half
      } // end if
   } // end while
   return position;
} // end binarySearch
```

a) Trace the `binarySearch` code using the following data.

	0	1	2	3	4	5	6	(MAX-1)
array:	2	3	4	5	7	8	9	

size: 7 value: 2

b) If size is 1,000,000, then what is the maximun number of comparisons of array items on a *successful search*?

c) If size is 1,000,000, then how many comparisons of array items would you expect on an *unsuccessful search*?

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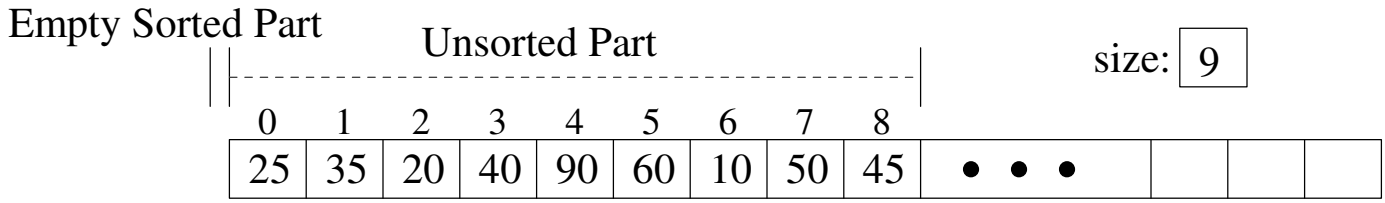
All *simple sort*s consist of two nested loops where:

- the outer loop keeps track of the dividing line between the sorted and unsorted part with the sorted part growing by one in size each iteration of the outer loop.
    - the inner loop's job is to do the work to extend the sorted part's size by one.

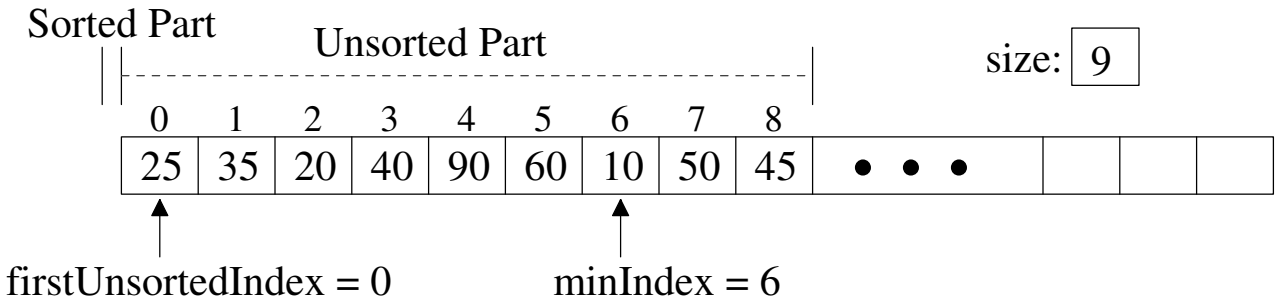
Initially, the sorted part is typically empty. The simple sorts differ in how their inner loops perform their job.

3. *Selection sort* is an example of a simple sort. Selection sort's inner loop scans the unsorted part of the array to find the minimum item. The minimum item in the unsorted part is then exchanged with the first unsorted item to extend the sorted part by one item.

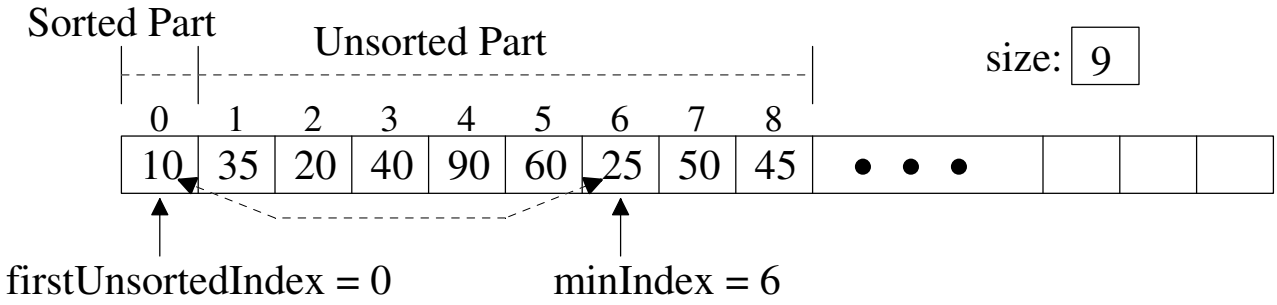
At the start of the first iteration of the outer loop, initial array is completely unsorted:



The inner loop scans the unsorted part and determines that the index of the minimum item, minIndex = 6.



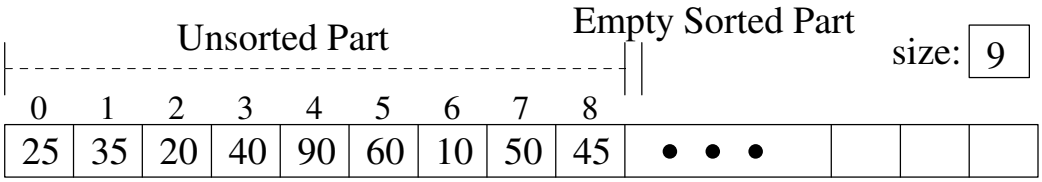
After the inner loop (but still inside the outer loop), the item at minIndex is exchanged with the item at firstUnsortedIndex. Thus, extending the Sorted Part of the array by one item.



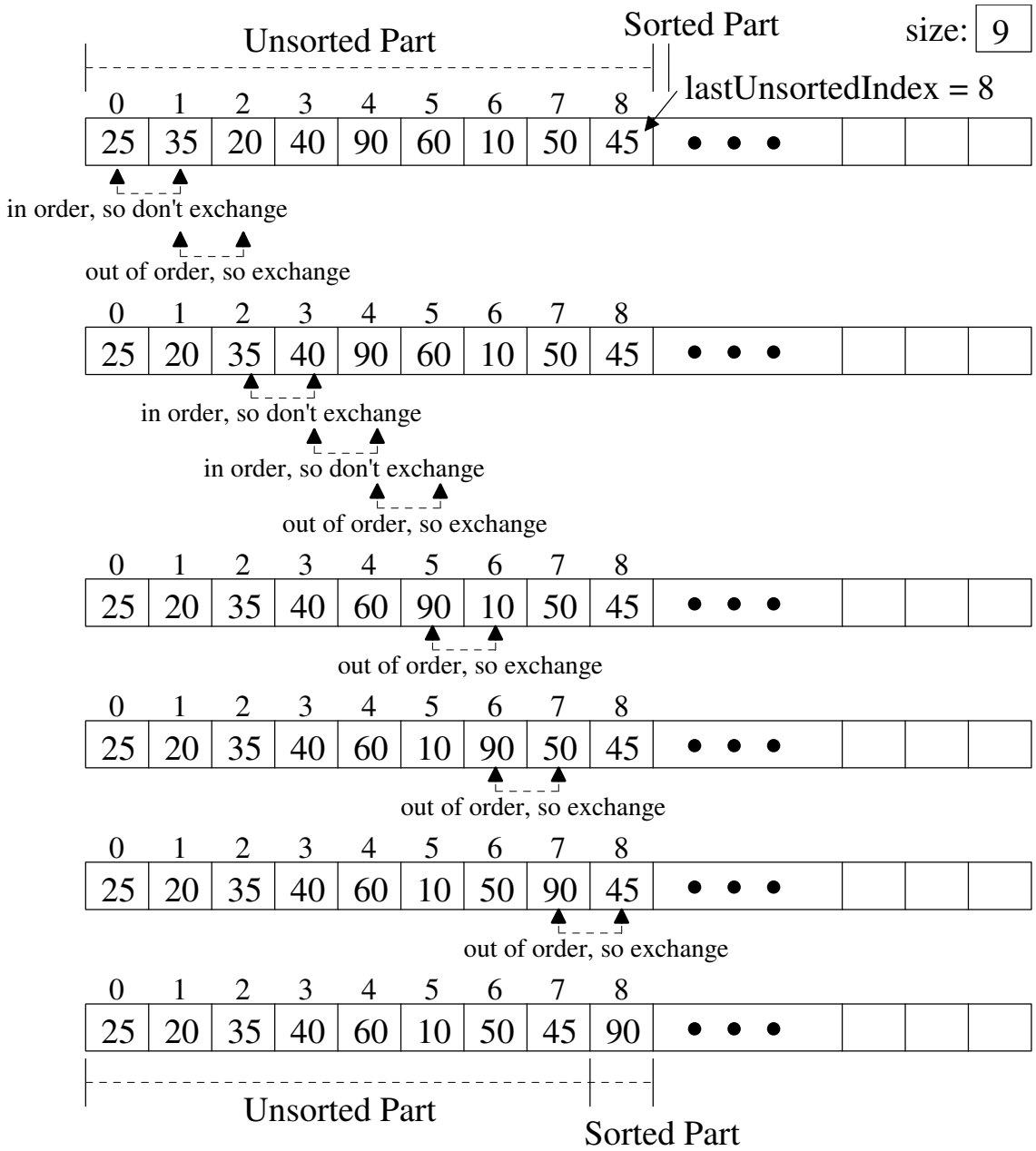
a) Write the code for the inner loop	b) Write the code to exchange the items

4. *Bubble sort* is another example of a simple sort. Bubble sort's inner loop scans the unsorted part of the array comparing adjacent items. If it finds adjacent items out of order, then it exchanges them. This causes the largest item to "bubble" up to the "top" of the unsorted part of the array.

At the start of the first iteration of the outer loop, initial array is completely unsorted:



The inner loop scans the unsorted part and determines that the index of the minimum item, minIndex = 6.



After the inner loop (but still inside the outer loop), there is nothing to do since the exchanges occurred inside the inner loop.

a) What would be true if we scanned the unsorted part and didn't need to do any exchanges?