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CSCI305 – Concepts of Programming Languages
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1. Regular Expressions and DFA:

2. Set Operations:

1. {1, 2, 3, 5}
2. {2, 3}
3. {1}

3. Symbolic Notation:

For all elements x in the set of real numbers, there exists an element y such that x is greater than y and y is contained in the set of all integers.

4. Basic Algorithms and Data Structures:

1. An algorithm with O(n) runtime would be one that simply goes through the entire list (assuming the list is length n) one node at a time until it finds the correct spot to insert the node.

```
public void insert(Node n) {
        for(int i = 0; i < n; i ++) {
                if value of node < List.get[i] {
                        insert node into List[i]
                }
        }
}
```

2. In a sorted array, using a binary search is the best option because it has a worst case runtime of O(logn). This is done by starting at the middle of the array and comparing that value to the one that we are searching for. Depending on whether the value is too high or too low, we recursively search either the lesser half or the greater half of the array until we find the correct value.

```
public void search(int minIndex, int maxIndex, int q) {
        int midIndex = array[maxIndex / 2];
        if q == array[midIndex] {return midIndex};
        else if q < array[midIndex] {
                search(minIndex, midIndex, q);
        } else {
                search(midIndex, maxIndex, q);
        }
}
```

Code Understanding:

The Mystery class creates an Integer List, then creates an ArrayList of integers. Then a for loop is used to add values from 0 to n into the ArrayList. The values are then shuffled and returned.

The guessResult method takes in the ArrayList of values and uses values.get to get two random values from the ArrayList and store them in an integer array, which is then returned.

The mystery method takes in the ArrayList of values and the two random values from the guessResult method. If the ArrayList does not contain any values the two guesses are returned. The first value in the ArrayList is stored, and then a new array of integers is created that tests whether the guesses are less than or equal to the first value of the ArrayList. The method is then called recursively until the base case of the values ArrayList being empty is met.

The operation class takes in a single integer and creates a new Integer List. It then creates two integer arrays, one called guess and one called result, and calls the guessResult and mystery methods respectively. The result array is then returned.

The main method creates a new Mystery object and creates an integer n that is initialized to 12. An integer array called result is also created and initializes it to whatever is returned from the operation method. The results are then printed out.

The program overall guesses whether integers stored in a list are less than or greater than a randomly generated integer in that list.