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Grokking the Coding Interview: Patterns for Coding Questions

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Pattern: Merge Intervals

Merge Intervals (medium)

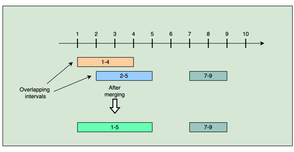
We'll cover the following

Problem Statement

Given a list of intervals, **merge all the overlapping intervals** to produce a list that has only mutually exclusive intervals.

Example 1:

```
Intervals: [[1,4], [2,5], [7,9]]
Output: [[1,5], [7,9]]
Explanation: Since the first two intervals [1,4] and [2,5] overlap, we merged them into
one [1,5].
```



Example 2:

```
Intervals: [[6,7], [2,4], [5,9]]
Output: [[2,4], [5,9]]
Explanation: Since the intervals [6,7] and [5,9] overlap, we merged them into one [5,9].
```

Example 3:

```
Intervals: [[1,4], [2,6], [3,5]]
Output: [[1,6]]
Explanation: Since all the given intervals overlap, we merged them into one.
```

Try it yourself

Try solving this question here:

Java | Python3 | JS | C++

```
import java.util.*;

class Interval {
  int start;
  int end;

  public Interval(int start, int end) {
    this.start = start;
    this.end = end;
  }
};

class MergeIntervals {

  public static List<Interval> merge(List<Interval> intervals) {
    List<Interval> mergedIntervals = new LinkedList<Interval>();
    // TODO: Write your code here
    return mergedIntervals;
  }

  public static void main(String[] args) {
    List<Interval> input = new ArrayList<Interval>();
    input.add(new Interval(1, 4));
    input.add(new Interval(2, 5));
    input.add(new Interval(7, 9));
    System.out.print("Merged intervals: ");
    for (Interval interval : MergeIntervals.merge(input))
      System.out.print("[" + interval.start + "," + interval.end + "] ");
```

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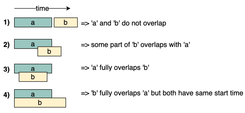
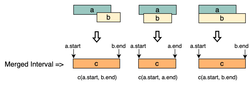
Solution

Let's take the example of two intervals ('a' and 'b') such that `a.start <= b.start`. There are four possible scenarios:



Our goal is to merge the intervals whenever they overlap. For the above-mentioned three overlapping scenarios (2, 3, and 4), this is how we will merge them:



The diagram above clearly shows a merging approach. Our algorithm will look like this:

1. Sort the intervals on the start time to ensure `a.start <= b.start`
2. If 'a' overlaps 'b' (i.e. `b.start <= a.end`), we need to merge them into a new interval 'c' such that:

```
c.start = a.start
c.end = max(a.end, b.end)
```

3. We will keep repeating the above two steps to merge 'c' with the next interval if it overlaps with 'c'.

Code

Here is what our algorithm will look like:

Java | Python3 | C++ | JS

```
import java.util.*;

class Interval {
  int start;
  int end;

  public Interval(int start, int end) {
    this.start = start;
    this.end = end;
  }
};

class MergeIntervals {

  public static List<Interval> merge(List<Interval> intervals) {
    if (intervals.size() < 2)
      return intervals;

    // sort the intervals by start time
    Collections.sort(intervals, (a, b) -> Integer.compare(a.start, b.start));

    List<Interval> mergedIntervals = new LinkedList<Interval>();
    Iterator<Interval> intervalItr = intervals.iterator();
    Interval interval = intervalItr.next();
    int start = interval.start;
    int end = interval.end;

    while (intervalItr.hasNext()) {
```

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Time complexity

The time complexity of the above algorithm is $O(N * logN)$, where 'N' is the total number of intervals. We are iterating the intervals only once which will take $O(N)$, in the beginning though, since we need to sort the intervals, our algorithm will take $O(N * logN)$.

Space complexity

The space complexity of the above algorithm will be $O(N)$ as we need to return a list containing all the merged intervals. We will also need $O(N)$ space for sorting. For Java, depending on its version, `Collections.sort()` either uses Merge sort or Timsort, and both these algorithms need $O(N)$ space. Overall, our algorithm has a space complexity of $O(N)$.

Similar Problems

Problem 1: Given a set of intervals, find out if any two intervals overlap.

Example:

```
Intervals: [[1,4], [2,5], [7,9]]
Output: true
Explanation: Intervals [1,4] and [2,5] overlap
```

Solution: We can follow the same approach as discussed above to find if any two intervals overlap.