Merge Intervals (medium)

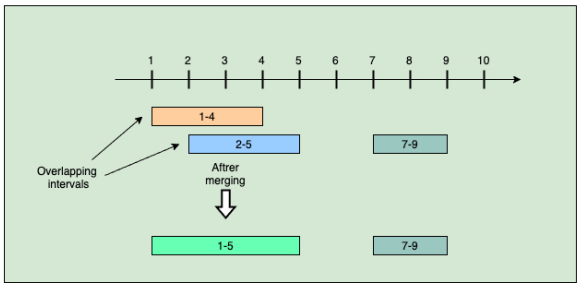
We'll cover the following

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++

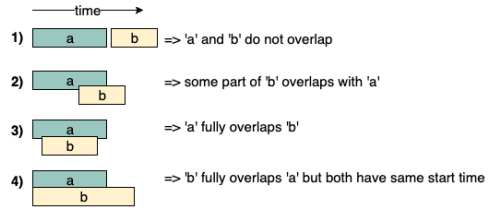
```
  merged = []
  // TODO: Write your code here
  return merged;
};

merged_intervals = merge([new Interval(1, 4), new Interval(2, 5), new Interval(7, 9)]);
result = "";
for(i=0; i < merged_intervals.length; i++) {
  result += merged_intervals[i].get_interval() + " ";
}
console.log(`Merged intervals: ${result}`)


merged_intervals = merge([new Interval(6, 7), new Interval(2, 4), new Interval(5, 9)]);
result = "";
for(i=0; i < merged_intervals.length; i++) {
  result += merged_intervals[i].get_interval() + " ";
}
console.log(`Merged intervals: ${result}`)


merged_intervals = merge([new Interval(1, 4), new Interval(2, 6), new Interval(3, 5)]);
result = "";
```

```
  result += merged_intervals[i].get_interval() + " ";
}
console.log(`Merged intervals: ${result}`)
```

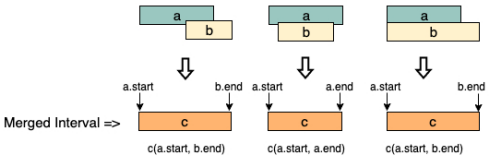
RUN SAVE RESET

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

```
class Interval {
  constructor(start, end) {
    this.start = start;
    this.end = end;
  }

  print_interval() {
    process.stdout.write(`[${this.start}, ${this.end}]`);
  }
}


function merge(intervals) {
  if (intervals.length < 2) {
    return intervals;
  }
  // sort the intervals on the start time
  intervals.sort((a, b) => a.start - b.start);

  const mergedIntervals = [];
  let start = intervals[0].start,
    end = intervals[0].end;
  for (i = 1; i < intervals.length; i++) {
    const interval = intervals[i];
    if (interval.start <= end) { // overlapping intervals, adjust the 'end'
      end = Math.max(interval.end, end);
    } else { // non-overlapping interval, add the previous interval and reset
      mergedIntervals.push(new Interval(start, end));
```

RUN SAVE RESET

Close

Output 1.946s

```
Merged intervals: [1, 5][7, 9]
Merged intervals: [2, 4][5, 9]
Merged intervals: [1, 6]
```

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, `Collection.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.