educative

Merge Intervals (medium)

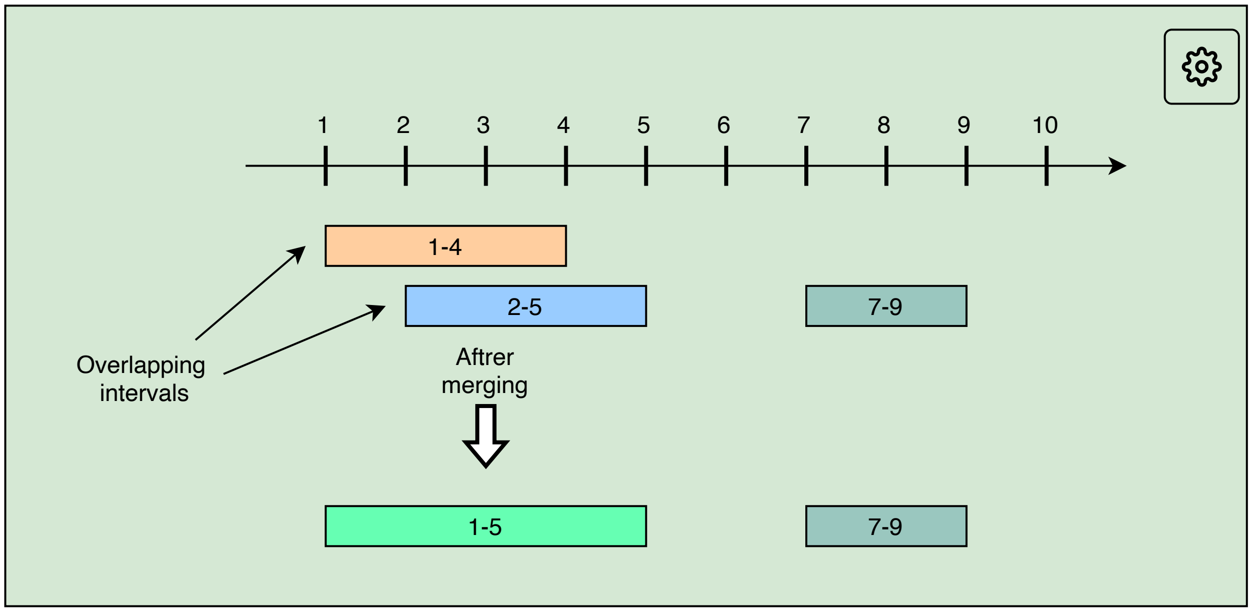
We'll cover the following

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 merge
d 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 the
m into one.
```

Try it yourself

Try solving this question here:

Java | Python3 | JS | C++

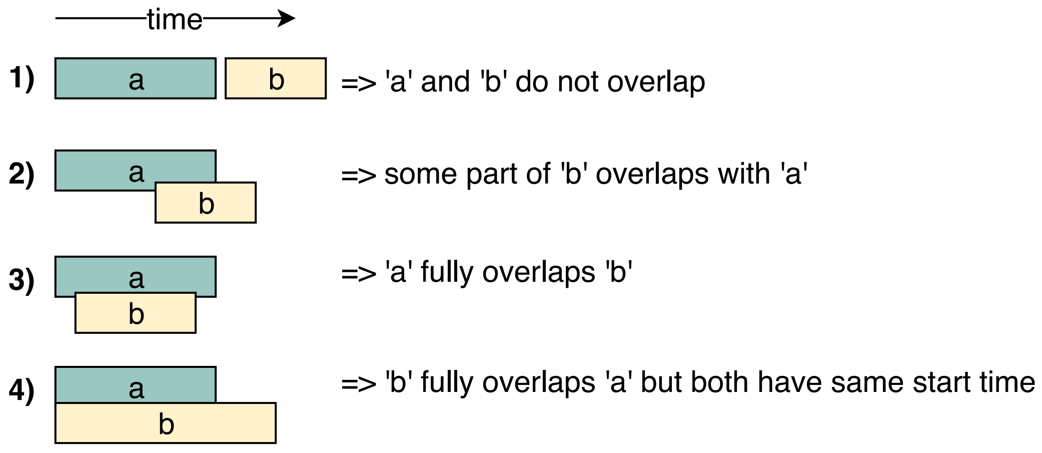
```
    interval = intervals[i]
    if interval.start<= end:
      end = max(interval.end,end)
    else:
      merged.append(Interval(start,end))
      start = interval.start
      end = interval.end

  merged.append(Interval(start,end))
  return merged
  # if overlapping, change end
  # else append and reset start and end


def main():
  print("Merged intervals: ", end='')
  for i in merge([Interval(1, 4), Interval(2, 5)
    i.print_interval()
  print()

  print("Merged intervals: ", end='')
  for i in merge([Interval(6, 7), Interval(2, 4)
    i.print_interval()
  print()

  print("Merged intervals: ", end='')
  for i in merge([Interval(1, 4), Interval(2, 6)
    i.print_interval()
```

Output 1.14s

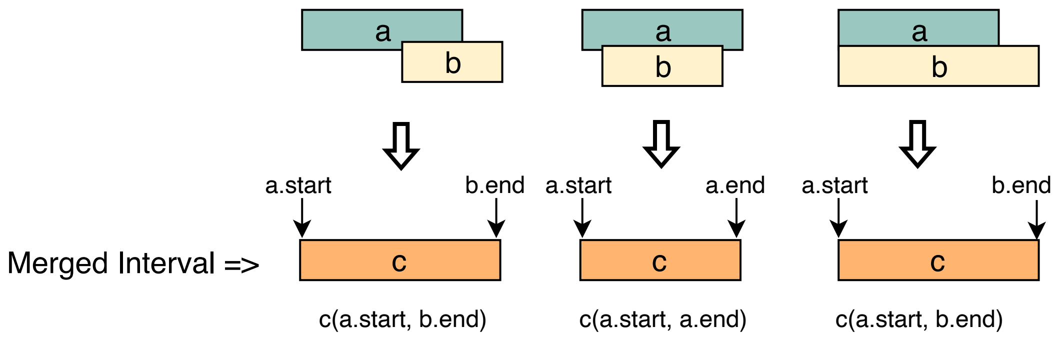
```
Merged intervals: [1, 5][7, 9]
Merged intervals: [2, 4][5, 9]
Merged intervals: [1, 6]
```

Solution

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


time
1)
a
b
=> 'a' and 'b' do not overlap
2)
a
b
=> some part of 'b' overlaps with 'a'
3)
a
b
=> 'a' fully overlaps 'b'
4)
a
b
=> 'b' fully overlaps 'a' but both have same start time

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

```

def merge(intervals):
  if len(intervals) < 2:
    return intervals

  # sort the intervals on the start time
  intervals.sort(key=lambda x: x.start)

  merged = []
  start = intervals[0].start
  end = intervals[0].end
  for i in range(1, len(intervals)):
    interval = intervals[i]
    if interval.start <= end:  # overlapping int
      end = max(interval.end, end)
    else:  # non-overlapping interval, add the p
      merged.append(Interval(start, end))
      start = interval.start
      end = interval.end

  # add the last interval
  merged.append(Interval(start, end))
  return merged


def main():
  print("Merged intervals: ", end='')
```

Output 0.15s

```
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 (https://en.wikipedia.org/wiki/Merge_sort) or Timsort (https://en.wikipedia.org/wiki/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.

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Introduction

Insert Interval (medium)

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