

# Daily Coding Problem #132

## Problem

This question was asked by Riot Games.

Design and implement a `HitCounter` class that keeps track of requests (or hits). It should support the following operations:

- `record(timestamp)`: records a hit that happened at `timestamp`
- `total()`: returns the total number of hits recorded
- `range(lower, upper)`: returns the number of hits that occurred between timestamps `lower` and `upper` (inclusive)

Follow-up: What if our system has limited memory?

## Solution

Let's first assume the timestamps in [Unix time](#), that is, integers.

We can naively create a `HitCounter` class by simply using an unsorted list to store all the hits, and implement `range` by querying over each hit one by one:

```
class HitCounter:
    def __init__(self):
        self.hits = []
```

```
def record(self, timestamp):
    self.hits.append(timestamp)

def total(self):
    return len(self.hits)

def range(self, lower, upper):
    count = 0
    for hit in self.hits:
        if lower <= hit <= upper:
            count += 1
    return count
```

Here, `record()` and `total()` would take constant time, but `range()` would take  $O(n)$  time.

One tradeoff we could make here is to use a sorted list or binary search tree to keep track of the hits. That way, `range()` would now take  $O(\lg n)$  time, but so would `record()`.

We'll use python's `bisect` library to maintain sortedness:

```
import bisect

class HitCounter:
    def __init__(self):
        self.hits = []

    def record(self, timestamp):
        bisect.insort_left(self.hits, timestamp)

    def total(self):
        return len(self.hits)

    def range(self, lower, upper):
        left = bisect.bisect_left(self.hits, lower)
        right = bisect.bisect_right(self.hits, upper)
        return right - left
```

This will still take up a lot of space, though -- one element for each timestamp.

To address the follow-up question, we can make several possible trade-offs.

One possible trade-off would be to sacrifice accuracy for memory by grouping together timestamps in a coarser granularity, such as minute or even hours. That means we'll lose some accuracy around the borders but we'd be using up to a constant factor less space.

For our solution, we'll keep track of each group in a tuple where the first item is the timestamp in minutes and the second is the number of hits occurring within that minute. We'll sort the tuples by minute for  $O(\lg n)$  record:

```
import bisect
from math import floor

class HitCounter:
    def __init__(self):
        self.counter = 0
        self.hits = [] # (timestamp in minutes, # of times)

    def record(self, timestamp):
        self.counter += 1

        minute = floor(timestamp / 60)
        i = bisect.bisect_left([hit[0] for hit in self.hits], minute)

        if i < len(self.hits) and self.hits[i][0] == minute:
            self.hits[i] = (minute, self.hits[i][1] + 1)
        else:
            self.hits.insert(i, (minute, 1))

    def total(self):
        return self.counter

    def range(self, lower, upper):
        lower_minute = floor(lower / 60)
        upper_minute = floor(upper / 60)
        lower_i = bisect.bisect_left([hit[0] for hit in self.hits], lower_minute)
        upper_i = bisect.bisect_right([hit[0] for hit in self.hits], upper_minute)

        return sum(self.hits[i][1] for i in range(lower_i, upper_i))
```

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