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Foundation Exam-Summer 2021-Section 2A

1. a) worst case: $O(nq)$
This would be the run-time since the worst case scenario would be if the boundaries were 0 to n-1. This would lead to the contingous subsequence sum to have a run time of $O(n)$. Since there are q questions, worst case runtime is $O(nq)$.
(variable)

b) best case: $O(q)$
The best-case scenario would be if the low and high boundries are the same index (0 to 0.) The contingous subsequence sum would have a constant number of operations (for-loop executed once), so the runtime is $O(1)$. Since there are q question $O(1) \times q = O(q)$, which is the best-case runtime.

2. - n users → $O(\log(n))$
- 10^4 users is 10 milliseconds
- assume $O(\log_{10}(n))$

$$10 \text{ milliseconds} = \text{constant} \times \log_{10}(10^4)$$
$$10 \text{ milliseconds} = \text{constant} \times 4$$
$$\text{constant} = 2.5 \text{ milliseconds}$$

$$20 \text{ milliseconds} = \text{constant} \times \log_{10}(\text{users})$$
$$20 \text{ ms} = 2.5 \text{ ms} \times \log_{10}(\text{users})$$
$$8 \text{ ms} = \log_{10}(\text{users})$$
$$10^8 = \text{users}$$

We can support 10^8 users while taking no more than 20 seconds per query.

(Question 3 on back)

3 $2^0+2^1+2^2+2^3+2^4$

$i=3 \qquad 2^{i+1}-1$

due to constraint of time I have "skipped" some parts of work but they are obvious nonetheless

$$\sum_{i=0}^{n}\sum_{j=0}^{i}2^j=\sum_{i=0}^{n}\left(2^{i+1}-1\right)=2\sum_{i=0}^{n}2^i-n$$

$$=2\left(2^{n+1}-1\right)-n$$

$$=2^{n+2}-n-2$$

$$\boxed{\sum_{i=0}^{n}\sum_{j=0}^{i}2^j=2^{n+2}-n-2}$$