

University of Waterloo
CS240 Winter 2025
Midterm Post-Mortem

Question 1 [11 marks]

- This question was generally well done.

Question 2 [12 marks]

- For part a, some students did not list all of Levels 1, 2, 3 as possible locations for key 4.
- For part b, the first line was well done. Some students gave a wrong answer for the second line.
- Part c was well done.
- Many students gave the wrong answer. The answer is derived from the sequence defined by $N(0) = 1, N(1) = 2, N(i) = N(i - 1) + N(i - 2) + 1$.
- Some students gave the incorrect answer of $\Theta(n)$.
- Some students gave the incorrect answer of $\Theta(n \log n)$ or $\Theta(\log n)$.

Question 3 [6 marks]

- Parts a and b were well done.
- For part c, many students stated the general run-time of MSD-Radix sort without tailoring it to the specific input described in the question.

Question 4 [4 marks]

- This question was well done.

Question 5 [5 marks]

- This question was generally well done.
- Some students incorrectly computed the number of inner iterations due to computing $p = n!$ instead of $p = n^i$.

- Some students duplicated their count of n resulting in a run-time of $\Theta(n^3 \log n)$ instead of the desired $\Theta(n^2 \log n)$
- Some students incorrectly determined the number of iterations of the inner while loop to be $\log n$ instead of $(i - 1) \log n$.

Question 6 [4 marks]

- This question was generally well done.
- Some students calculated the number of instances as $|I_n| = n$ instead of $|I_n| = n!$.
- Some students did not correctly calculate the number of problem instances for each $A[0] = k$. There are $(n - 1)!$ permutations that start with each k .
- Some students did not correctly use the definition of average run-time.

Question 7 [5 marks]

- This question was well done.
- Some students provided trees that were restructured incorrectly.
- Some students incorrectly duplicated nodes or omitted nodes.

Question 8 [4 marks]

- This question was generally well done.
- For part a, some students provided skip lists with keys out of order. Regardless of insertion order, every level of a skip list should be in ascending order.
- For part b, many students provided an incorrect answer of $n(\frac{1}{2})^{10}$ instead of $(\frac{1}{2})^{10n}$

Question 9 [3 marks]

- Many students did not include leaf-references for internal nodes.
- Many students incorrectly provided a trie with the root node storing index 0 instead of index 2.

Question 10 [4 marks]

- Many students did not attempt or provided incomplete solutions for this question.
- Many students provided a sorting algorithm that did not satisfy the desired run-time of $O(n \log \log n)$.
- A common sorting algorithm that did not satisfy the desired run-time involved storing all distinct keys in a heap. This would require searching for keys in a heap which is an inefficient operation for heaps.
- Another common sorting algorithm that did not satisfy the desired run-time involved bucket sort on distinct keys. This would require knowledge of the range of keys.
- Many students provided some variation of `QuickSort` that did not satisfy the desired run-time.

Question 11 [4 marks]

- Some students provided an algorithm searching only $\log k$ levels. However, some of the k largest integers can exist in levels up to level k
- Some students provided an algorithm searching k levels. However, this does not satisfy the desired run-time.
- Many students modified the original heap (usually by calling `delete-max`). This was not allowed by the question.
- Many students claimed that the first k elements of H , in level order, are the largest k elements of H . This is not true.