# Question 3 – Checklist Table

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Tasks** | **Mark** | **Checklist**  **(Yes/no) and person(s) to work on this task** |
| 1 | Quick-select algorithm for searching the *k*-th element.  - Correct implementation of searching *k*-th element using quick-select algorithm.  - Output the intermediate results for a random array of 10 elements for tutor to inspect the correctness of the algorithms. | 4 | Yes  (Fang Jee, Michelle) |
| 2 | Test the Quick-select algorithm with  - Different array sizes (10,000, 100,000, 1,000,000, etc.) that can show significant results.  - Different pivot (random pivot vs fixed pivot).  - Different cases (e.g. best, average, and worst). | 4 | Yes  (Fang Jee, Michelle) |
| 3 | Merge-sort algorithm for searching the *k*-th element.  - Correct implementation of searching *k*-th element using merge-sort algorithm.  - Output the intermediate results for a random array of 10 elements for tutor to inspect the correctness of algorithms. | 4 | Yes  (Justin, Kah Ming) |
| 4 | Test the Merge-sort algorithm with  - Different array sizes (10,000, 100,000, 1,000,000, etc.) that can show significant results.  - Test the Merge-sort algorithm with different cases (e.g. best, average, and worst). | 4 | Yes  (Justin, Kah Ming) |
| 5 | - Include the above experiment results that can be used to perform a comparative analysis (such as drawing the graphs for comparison) between the two algorithms (Quick-select & Merge-sort) in the report.  - Conclude your findings in the report. | 4 | Yes  (Michelle) |

# Quick-select algorithm

## Array size test (k = 80)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Array size, *n*** | **10,000** | **100,000** | **1,000,000** | **5,000,000** |
| Attempt 1 (s) | 0.000999 | 0.001983 | 0.033009 | 0.170038 |
| Attempt 2 (s) | 0.000992 | 0.002001 | 0.033166 | 0.179039 |
| Attempt 3 (s) | 0.001001 | 0.002001 | 0.034009 | 0.182043 |
| Attempt 4 (s) | 0.000984 | 0.003 | 0.036008 | 0.183031 |
| Attempt 5 (s) | 0.001001 | 0.002 | 0.035008 | 0.17803 |
| Average Duration (s) | 0.0009954 | 0.002197 | 0.03424 | 0.1784362 |

## Pivot test (same set of array size = 10000)

|  |  |  |  |
| --- | --- | --- | --- |
| **Pivot selection** | **Random** | **Fixed** | **kth element** |
| Attempt 1 (s) | 0.000991 | 0.001 | 38 |
| Attempt 2 (s) | 0.001001 | 0.001001 | 1638 |
| Attempt 3 (s) | 0 | 0.000999 | 5690 |
| Attempt 4 (s) | 0 | 0.001 | 7653 |
| Attempt 5 (s) | 0.001 | 0.001001 | 8654 |
| Average Duration (s) | 0.0005984 | 0.0010002 | - |

## Test of different cases (same set of array size = 10000)

|  |  |  |  |
| --- | --- | --- | --- |
| **Case** | **Best** | **Average** | **Worst** |
| Attempt 1 (s) | 0 | 0  (k=37) | 0.112036 |
| Attempt 2 (s) | 0 | 0.001 (k=1238) | 0.112026 |
| Attempt 3 (s) | 0.001001 | 0.001001 (k=4632) | 0.112036 |
| Attempt 4 (s) | 0 | 0  (k=9574) | 0.112024 |
| Attempt 5 (s) | 0.000998 | 0.001 (k=58) | 0.111036 |
| Average duration (s) | 0.0003998 | 0.0006002 | 0.1118316 |

# Merge-sort algorithm

## Array size test

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Array size, *n*** | **10,000** | **100,000** | **1,000,000** | **5,000,000** |
| Attempt 1 (s) | 0.00499s | 0.048977s | 69.311s | 1710.2s |
| Attempt 2 (s) | 0.004978s | 0.04763s | 72.883s | 1713.5s |
| Attempt 3 (s) | 0.005321s | 0.04878s | 73.126s | 1695.3s |
| Attempt 4 (s) | 0.005122s | 0.04923s | 69.788s | 1708.5s |
| Attempt 5 (s) | 0.005264s | 0.045243s | 74.312s | 1705.1s |
| Average Duration (s) | 0.005135s | 0.047972s | 71.884s | 1706.52s |

## Test of different cases (same set of array size = 10000)

|  |  |  |  |
| --- | --- | --- | --- |
| **Case** | **Best** | **Average** | **Worst** |
| Attempt 1 (s) | 0.001997s | 0.002995s | 0.005027s |
| Attempt 2 (s) | 0.001999s | 0.002992s | 0.006028s |
| Attempt 3 (s) | 0.001992s | 0.003987s | 0.004984s |
| Attempt 4 (s) | 0.001998s | 0.00399s | 0.005027s |
| Attempt 5 (s) | 0.001998s | 0.002975s | 0.004986s |
| Average duration (s) | 0.0019968s | 0.0033878s | 0.0052104s |

# Comparative analysis

# Conclusion

For quick-select algorithm, using a random pivot performs 40.17% faster as compared to using a fixed pivot, which is the last element of the partition in this case. As for the different cases, quick-select algorithm performs at a similar speed for best and average case, where the time complexity is given by O(*n*). For the worst case, quick-select algorithm performs significantly slower as compared to the other two cases, where the time complexity is given by O(*n*2); the time difference between best case and worst case is 0.1114318s, which is roughly 278 times of the best case’ time of 0.0003998s. For a better representation of the sorted array, the partition through using three sequences (L, E, G) could be used instead.