Heap-based Priority Queue (OpenMP)

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CS-309 Parallel Computing

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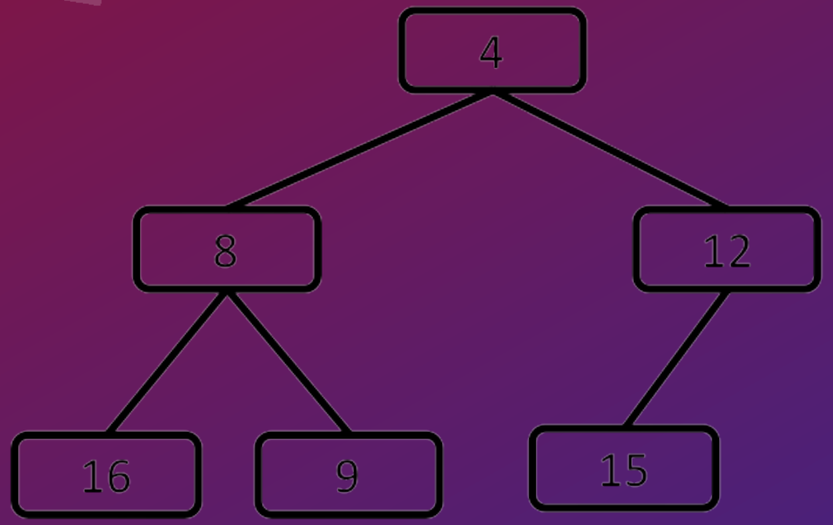
Priority Queues

- Priority queues are fundamental data structures.
- Insert and DeleteMin Operations.
- Graph problem: Dijkstra's algorithm
- Branch-and-Bound problem: 0/1 Knapsack

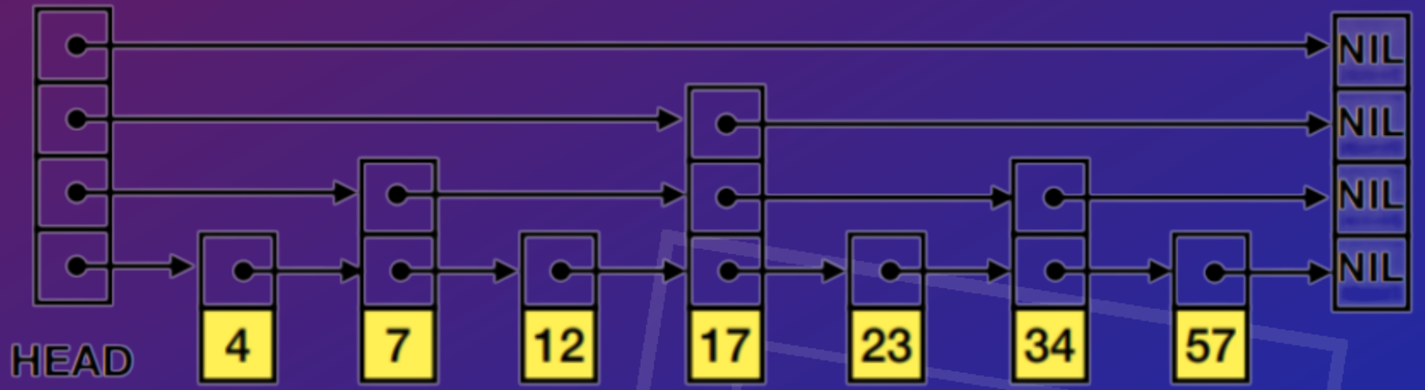
Concurrent Priority Queue Design Choices

Heap Based Priority Queue



- Computation Complexity: O(logN)
- Space Complexity: N + O(1)
- Limitation: Scalability

Skip-List Based Priority Queue



- Computation Complexity: O(logN)
- Space Complexity: O(N) + O(1)
- Dynamic memory management.

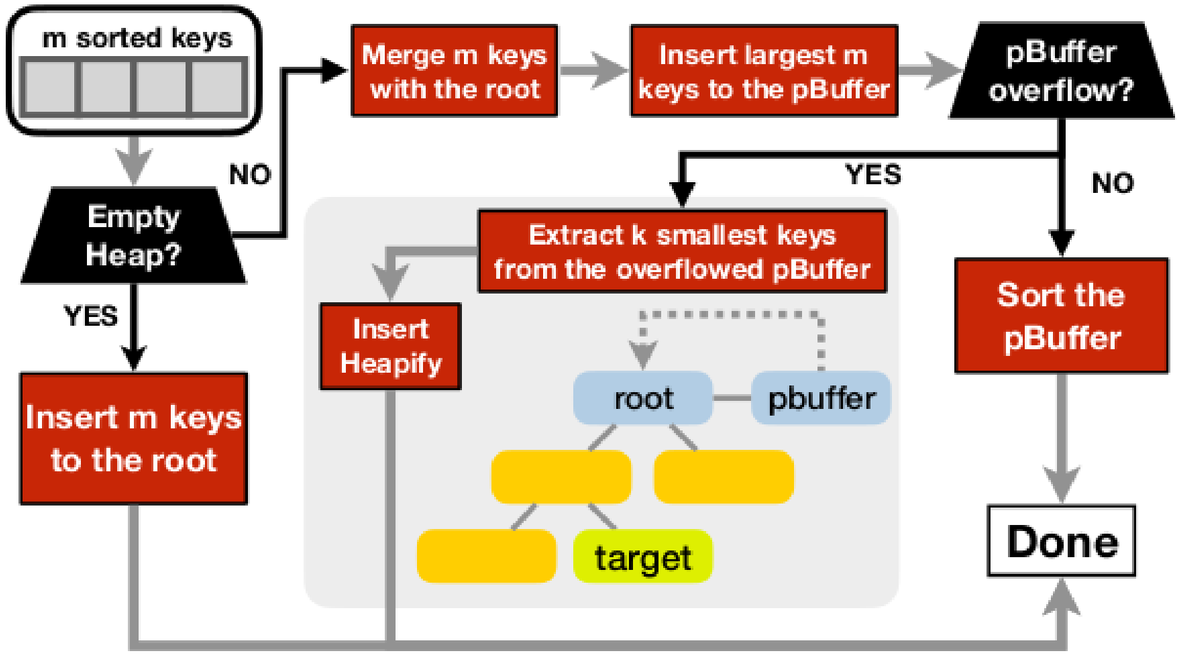
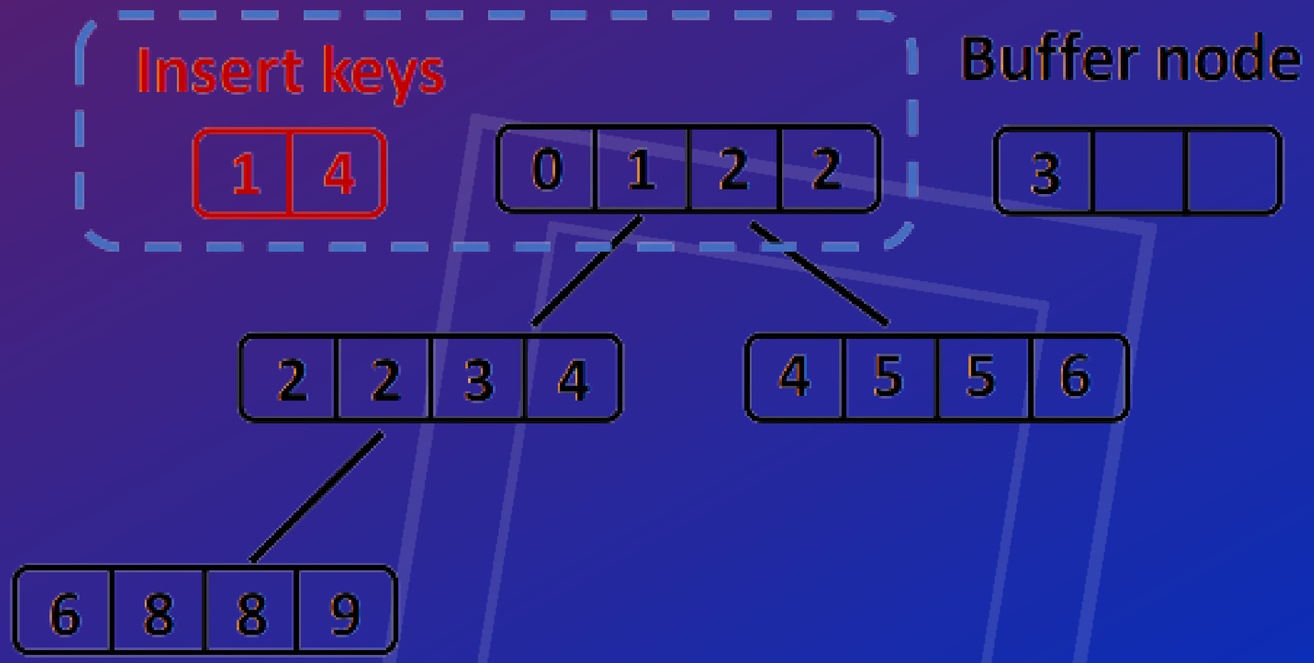


Figure 3: BGPQ Insert Operations

BGPQ INSERT OPERATION

- Insert keys are sorted first and then merged with the root node.
  - Smallest keys are placed back into the root.



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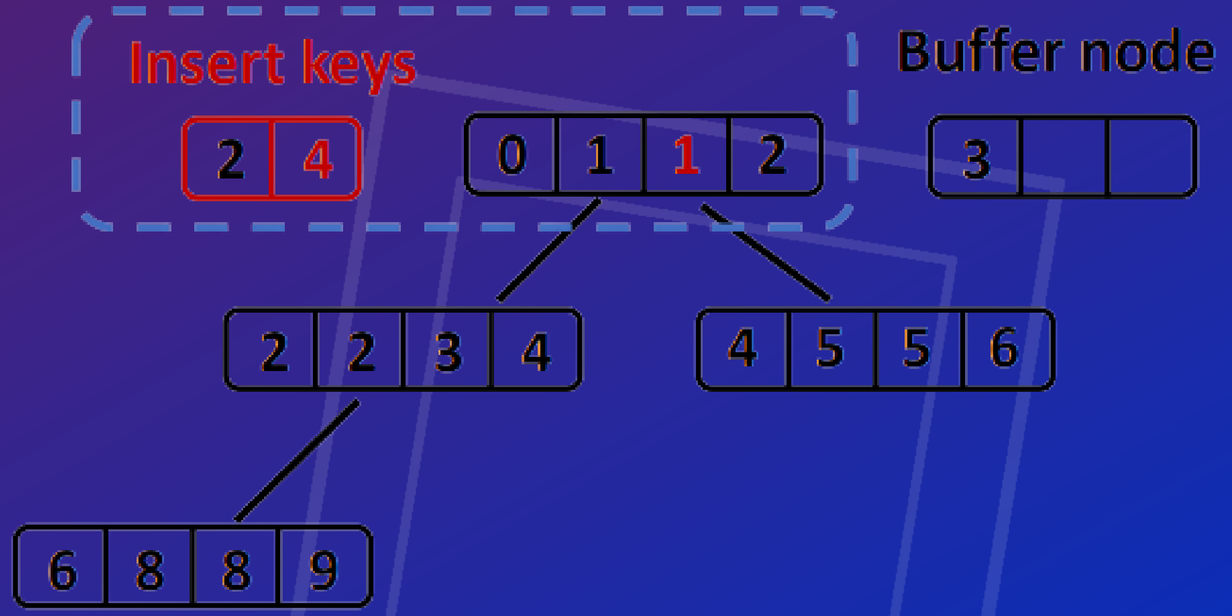

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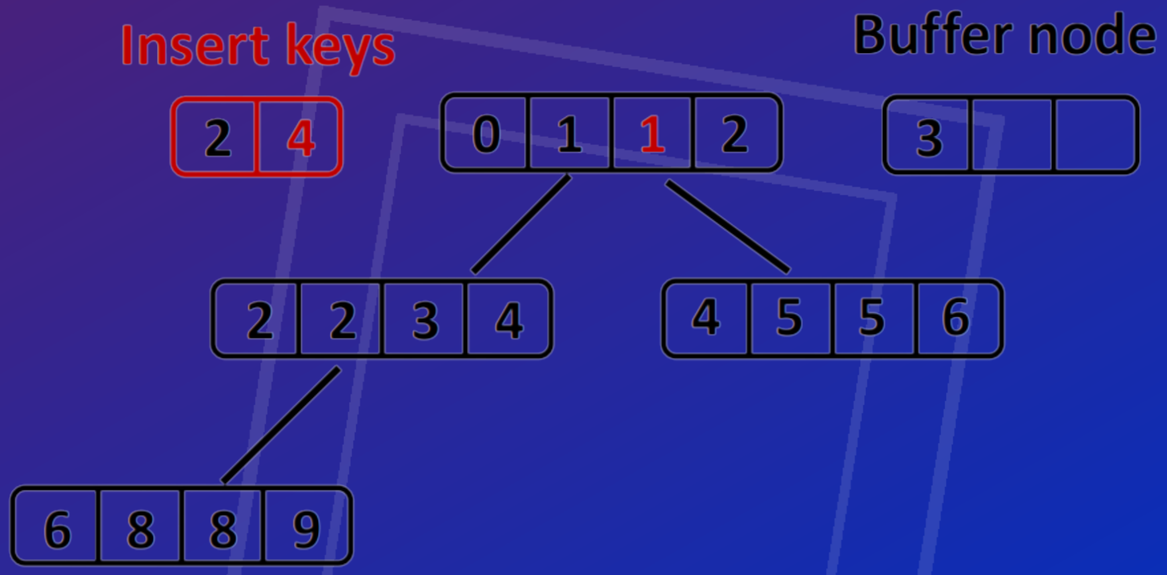
- If the buffer can hold all insert keys, updated insert keys will be placed in the buffer.



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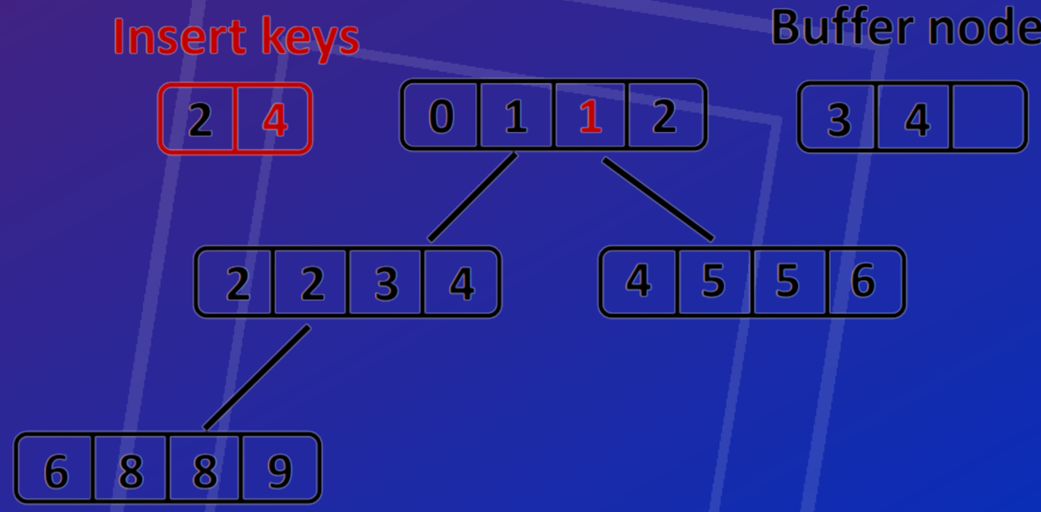
- Otherwise, an insert heapify will be triggered.
  - Insert heapify traverses the path from the root to the target.



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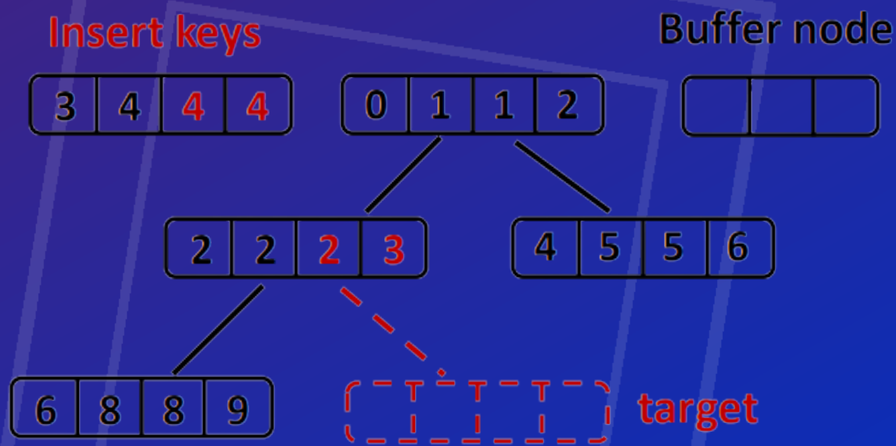

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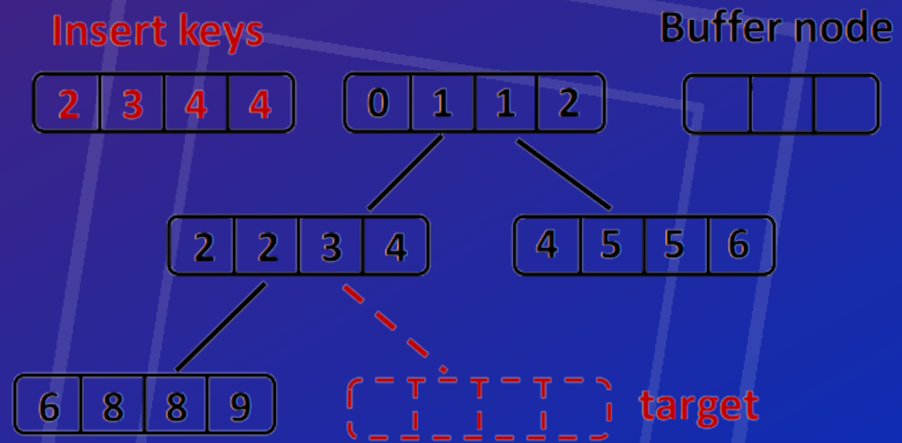

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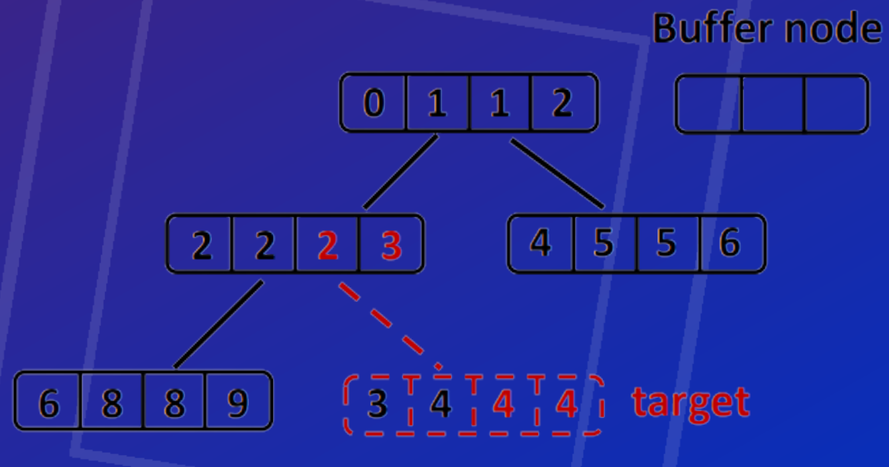


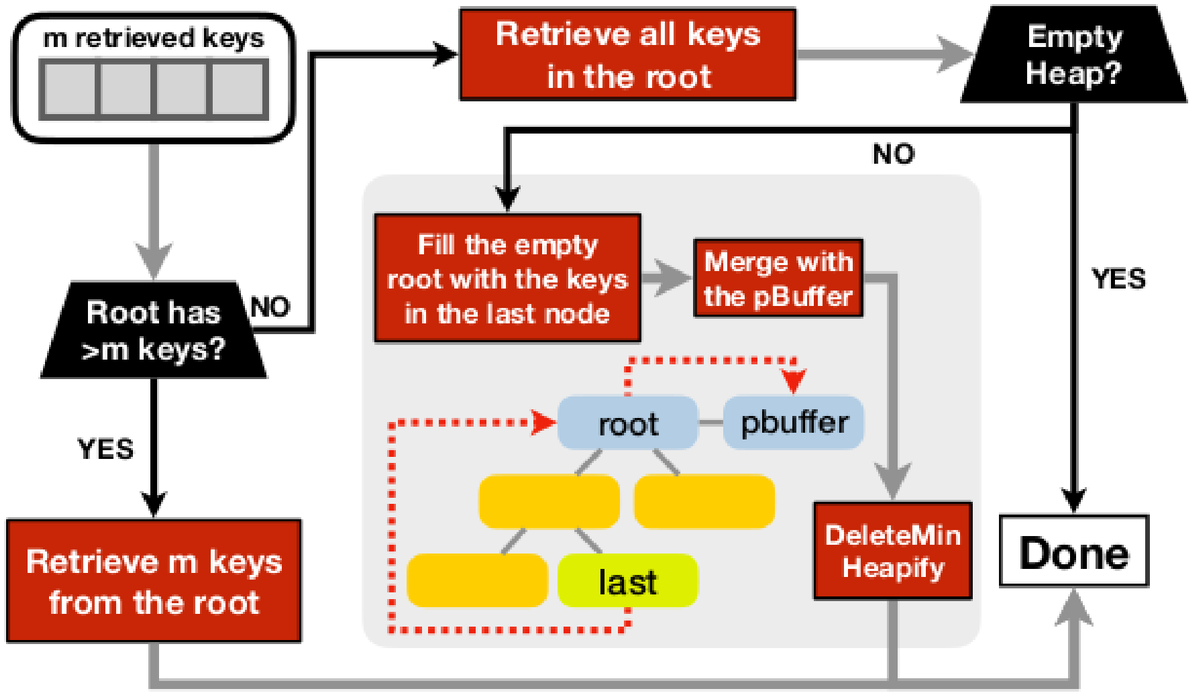
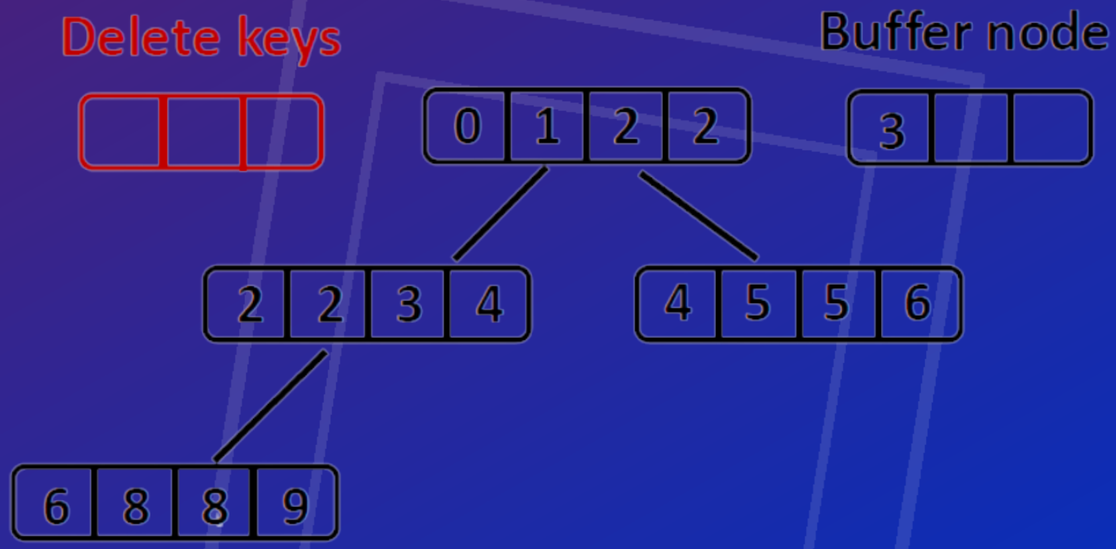


Figure 4: BGPQ DeleteMin Operations

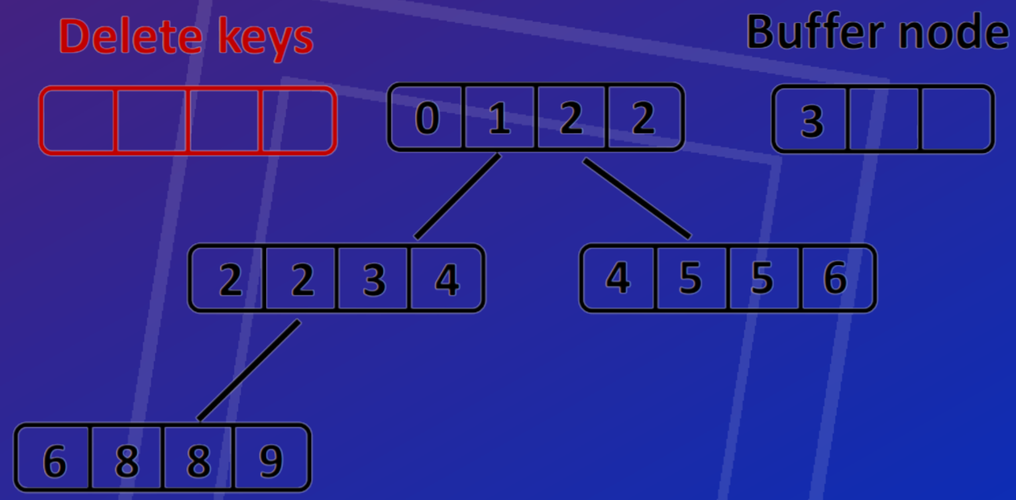
BGPQ DELETE OPERATION

- If the root contains enough keys to delete, they are retrieved directly.



BGPQ Delete Operation

- If the root contains enough keys to delete, they are retrieved directly.
- Otherwise, if the root becomes empty, a deleteMin heapify is triggered.



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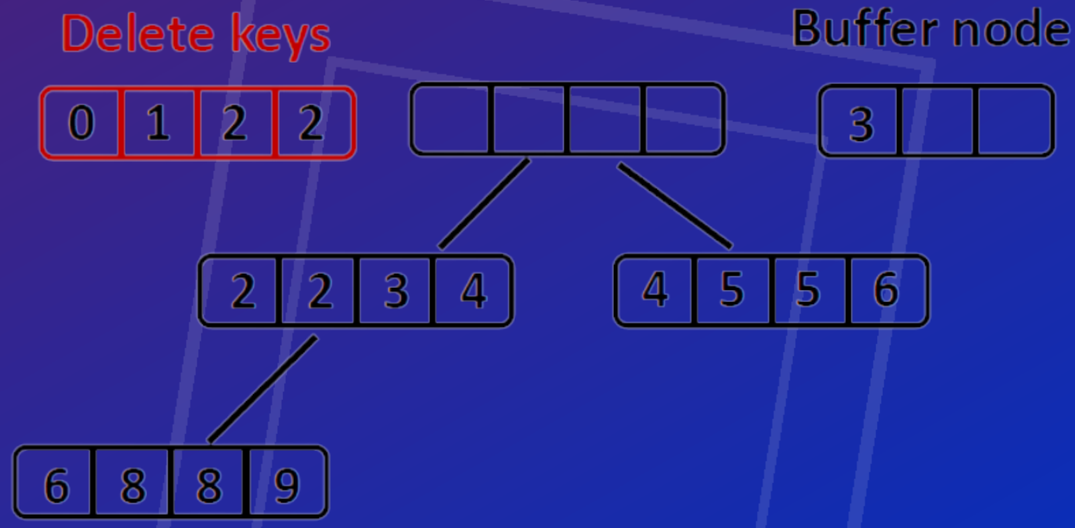

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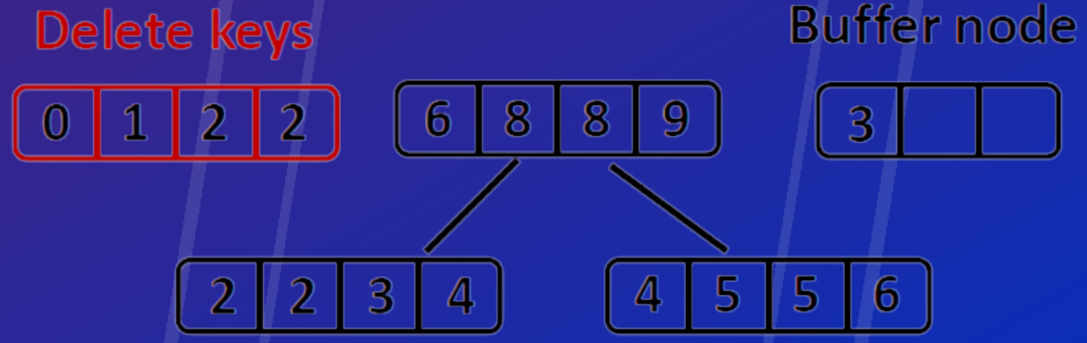

Conclusion

It was a wonderful learning experience for us while working on this project. The joy of working and the thrill involved while tackling the various problems and challenges gave us a feel of the industry. We studied existing concurrent priority queue implementations and their corresponding GPU friendliness and also successfully implemented BGPQ, a GPU-friendly priority queue. We enjoyed each and every bit of work we had put in.

Thank you!