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CS 300

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| OPERATION | VECTOR | HASH TABLE | BINARY SEARCH TREE |
| File Read | O(n) | O(n) | O(n) |
| Insert Course | O(1)(Amortized) | O(1)(Average)/O(n)(Worst) | O(log n) |
| Search Course | O(n) | O(1)(Average)/O(n)(Worst) | O(log n) |
| Print Courses in Order | O(n log n)(Sorting) | O(n log n)(Sorting) | O(n) |

The vector data structure provides a simple implementation that is efficient for small datasets and supports fast index-based access. However, search operations require iterating through the entire list, making it inefficient for large datasets. Additionally, sorting is necessary to maintain alphanumeric order, leading to an O(n log n) cost.

A hash table offers fast search times, with an average complexity of O(1) for lookup operations. This makes it efficient for retrieving course information quickly. However, in cases where collisions occur, the worst-case search time degrades to O(n). Additionally, hash tables do not maintain a sorted order, requiring an additional sorting step to print course information in sequence.

The binary search tree (BST) maintains a sorted order, making search and print operations more efficient. In a balanced BST, search and insert operations occur in O(log n) time, providing a structured and optimized approach. However, if the tree becomes unbalanced, these operations can degrade to O(n), necessitating additional balancing mechanisms such as AVL or Red-Black Trees.

Based on this analysis, I recommend using the binary search tree for this project. The BST efficiently maintains an ordered list of courses, allowing O(log n) searches and inserts while keeping the print operation at O(n). While a hash table offers fast lookups, it does not maintain order and requires additional sorting. The vector, although simple, has an O(n) search time, making it less suitable for large datasets. By using a BST, the program can efficiently handle course retrieval and maintain an optimized structure for advising purposes.