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CS 300

Project One

Runtime Analysis:

Vector

Task: Printing course information using the vector data structure.

|  |  |  |  |
| --- | --- | --- | --- |
| Code | Line Cost | # Times Executed | Total Cost |
| For all courses | 1 | N | N |
| If the course is the same as corseNumber | 1 | N | N |
| Print out the course information | 1 | 1 | 1 |
| For each prerequisite of the course | 1 | N | N |
| print the prerequisite course information | 1 | N | N |

Total Cost: 4n + 1

Runtime: O(n)

Hash Table

Task: Printing course information using the hash table data structure.

|  |  |  |  |
| --- | --- | --- | --- |
| Code | Line Cost | # Times Executed | Total Cost |
| Hash the courseNumber to get the index | 1 | 1 | 1 |
| Retrieve course from the hash table | 1 | 1 | 1 |
| print out the course information | 1 | 1 | 1 |
| for each prerequisite of the course | 1 | N | N |
| print the prerequisite course information | 1 | N | N |

Total Cost: 2n + 3

Runtime: O(n)

Binary Search Tree (BST)

Task: Printing course information using the BST data structure.

|  |  |  |  |
| --- | --- | --- | --- |
| Code | Line Cost | # Times Executed | Total Cost |
| Traverse the BST to find the course | 1 | log n (for balanced tree) | log n |
| print out the course information | 1 | 1 | 1 |
| for each prerequisite of the course | 1 | N | N |
| print the prerequisite course information | 1 | N | N |

Total Cost: 2n + log n + 1

Runtime: O(n)Advantages and Disadvantages:

Vector:

Advantages:

Simplicity and ease of use.

Continuous memory layout ensures cache efficiency.

O(1) direct access if the position of the item is known.

Dynamic resizing capability.

Disadvantages:

O(n) insertion/deletion can be slow.

O(n) for unordered searches.

Sorting can introduce overhead.

Hash Table:

Advantages:

O(1) average lookup time for well-designed tables.

Suitable for key-value data structures.

Scalability for large datasets.

Disadvantages:

Collisions can increase complexity.

Memory overhead for structure and handling collisions.

Doesn't maintain order inherently.

Binary Search Tree (BST):

Advantages:

Keeps data in sorted order.

Logarithmic time complexity for balanced trees.

Suitable for range queries.

Disadvantages:

More complex than vectors or hash tables.

Extra memory for structural elements.

Without balancing, can degrade to O(n) operations.

Recommendation and Justification:

Given the advisor's needs, a Hash Table combined with a Binary Search Tree (BST) is recommended. Hash tables ensure quick lookups, making it suitable for regular querying of course information, whereas BSTs can be used for operations requiring sorted data, like printing all courses in alphanumeric order. This approach balances between the simplicity of vectors, the speed and efficiency of hash tables, and the ordered nature of BSTs. The combined strength of Hash Tables and BSTs provides a comprehensive solution tailored to the advising program's requirements.