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**Evaluate the worst-case runtime complexities of the three data structures**

**Vector:**

LoadCoursesFromFile():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside while loop (plus final check)** | 4 | 1 | 4 |
| **One-line operations in loop** | 4 | n | 4n |
| **InsertCourse() function call in loop** | O(n) | n | n2 |
| **Total Cost** | | | 4 + 4n + n2 |
| **Runtime** | | | O(n2) |

InsertCourse():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside for each loop (plus loop init and final check)** | 3 | 1 | 3 |
| **One-line operations in loop (k prerequisites)** | 3 | k | 3k |
| **Search() function call in loop** | O(n) | k | kn |
| **Total Cost** | | | 3 + 3k + kn |
| **Runtime** | | | O(n) |

PrintCourse():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations** | 3 | 1 | 3 |
| **Search() function call** | O(n) | 1 | n |
| **Total Cost** | | | 3 + n |
| **Runtime** | | | O(n) |

Search():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside for each loop (plus loop init and final check)** | 3 | 1 | 3 |
| **One-line operations in loop** | 3 | n | 3n |
| **Total Cost** | | | 3 + 3n |
| **Runtime** | | | O(n) |

**Hash table:**

LoadCoursesFromFile():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside while loop (plus final check)** | 5 | 1 | 5 |
| **One-line operations in loop** | 4 | n | 4n |
| **InsertCourse() function call in loop** | O(n) | n | n2 |
| **Total Cost** | | | 5 + 4n + n2 |
| **Runtime** | | | O(n2) |

InsertCourse():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside for each loop (plus loop init and final check)** | 6 | 1 | 6 |
| **One-line operations in loop (k prerequisites)** | 3 | k | 3k |
| **Search() function call in loop** | O(n) | k | kn |
| **Total Cost** | | | 6 + 3k + kn |
| **Runtime** | | | O(n) |

PrintCourse():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations** | 3 | 1 | 3 |
| **Search() function call** | O(n) | 1 | n |
| **Total Cost** | | | 3 + n |
| **Runtime** | | | O(n) |

Search():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside while loop (plus final check)** | 4 | 1 | 4 |
| **One-line operations in loop** | 3 | n | 3n |
| **Total Cost** | | | 4 + 3n |
| **Runtime** | | | O(n) |

**Binary tree:**

LoadCoursesFromFile():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside while loop (plus final check)** | 4 | 1 | 4 |
| **One-line operations in loop** | 4 | n | 4n |
| **InsertCourse() function call in loop** | O(n) | n | n2 |
| **Total Cost** | | | 3 + 4n + n2 |
| **Runtime** | | | O(n2) |

InsertCourse():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside both loops (plus loop init and both final checks)** | 6 | 1 | 6 |
| **One-line operations in for each loop (k prerequisites)** | 3 | k | 3k |
| **Search() function call in for each loop** | O(n) | k | kn |
| **One-line operations in while loop** | 4 | n | 4n |
| **Total Cost** | | | 6 + 3k + kn + 4n |
| **Runtime** | | | O(n) |

PrintCourse():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations** | 3 | 1 | 3 |
| **Search() function call** | O(n) | 1 | n |
| **Total Cost** | | | 3 + n |
| **Runtime** | | | O(n) |

Search():

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Line Cost** | **# Times Executes** | **Total Cost** |
| **One-line operations outside for each loop (plus loop init and final check)** | 3 | 1 | 3 |
| **One-line operations in loop** | 4 | n | 4n |
| **Total Cost** | | | 3 + 4n |
| **Runtime** | | | O(n) |