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BSc Engineering, Semester 8 (Intake 19)
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CS4522 Advanced Algorithms

Quiz 0 (Review of Basics), 30 Minutes

1. If $A=(a_{ij})$, $B=(b_{ij})$ and $C=(c_{ij})$ are square $n \times n$ matrices, then in the matrix product $C = A \cdot B$, the entry c_{ij} is defined for $i, j = 1, 2, \dots, n$ by:

$$c_{ij} = \sum_{k=1}^n a_{ik} \cdot b_{kj}$$

Answer the following using the above.

- (a). Give an algorithm that takes two matrices A and B as input and returns matrix C.
 - (b). What is the complexity of the algorithm in (a)?
2. Suppose you need to search for item k in an arbitrary array $A[1 \dots n]$.
- (a). Give a *recursive algorithm* for linear search. It should return a valid index i where $1 \leq i \leq n$ if k is in A or -1 otherwise. Assume k appears in A at most once.
 - (b). What is the complexity of your algorithm in (a)?
 - (c). If the input array A is sorted, can we search faster? If yes, describe how and with what complexity.
3. Consider the following algorithm that takes a sub-array $A[i \dots j]$ as input. The `re-arrange()` routine re-arranges the elements of sub-array $A[i \dots j]$ and returns an integer q where $q \approx (i+j)/2$ taking time $\Theta(n)$, where $n=j-i+1$.

```
MyAlgo(A, i, j)
if (i < j)
    q = re-arrange(A, i, j)
    MyAlgo(A, i, q)
    MyAlgo(A, q+1, j)
```

- (a). Write a recurrence for the running time of the algorithm $T(n)$.
 - (b). Solve the recurrence and find the complexity of the algorithm.
4. Suppose we insert into an initially empty binary search tree the following 10 keys, in the listed order: 2, 4, 3, 5, 7, 8, 10, 11, 1, 12.
- (a). Show the binary search tree after inserting all 10 keys.
 - (b). Give an algorithm to visit every node and display the keys in sorted order.