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Insertion Sort and Running Times

LATEST SUBMISSION GRADE
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1. What is the expression for the summation $1 + 2 + 3 + \cdots + n$?

1 / 1 point

$\frac{n}{2}(n+1)$

((n+1) * n)/2

Correct
Let $S = 1 + 2 + 3 + \cdots + n$. We can also write $S = (n) + (n-1) + \cdots + 1$. Adding the corresponding terms in the two summations, we get $2S = (n+1) + (n+1) + \cdots + (n+1) = (n+1) \times n$. Therefore, $S = \frac{n(n+1)}{2}$.

2. (Consider the python function below (read the comments carefully)

1 / 1 point

```
1  def foo(n):
2      sum = 0 # time cost of assignment = c1
3      for i in range(n): # cost for each (increment i and check if in range) = c2
4          sum = sum + i * i # cost of addition = c3,
5          # cost of multiplication = c4 and
6          # cost of assignment = c1
7      return sum # cost of return = c5
```

What is the overall time cost of calling the "foo" function, in terms of $n, c1, c2, c3, c4$ and $c5$?

- (selected) $(n+1) * c1 + n * (c2 + c3 + c4) + c5$
- $n * n * (c2 + c3 + c4 + c1) + c1 + c5$
- $c1 + c2 + c3 + c4 + c5$
- $c1 + n * (c2 + c3 + c4) + c5$

Correct

3. Consider the following array, which is *almost* sorted in ascending order. There are just two elements (3 and 7) out of place.

1 / 1 point

$A = [1, 2, 7, 4, 5, 6, 3, 8, 9]$

Select all the true facts about running insertion sort on A from the list below. Ensure that no wrong choices are selected.

- [x] During the execution of insertion sort, when the element 7 is to be inserted into the sorted portion $[1, 2]$, no swap operation will occur because $2 < 7$.

Correct

- [x] After 7 has been inserted, the insertion of elements 4, 5 and 6 will incur one swap operation each, with the number 7 remaining at the end of the sorted portion of the array.

Correct

- [x] Insertion of the element 3 into the sorted portion $[1, 2, 4, 5, 6, 7]$ involves 4 swap operations, with 4, 5, 6 and 7 respectively.

Correct

4. Consider this array of size n sorted in descending order: $[n, n-1, \ldots, 1]$.

1 / 1 point

Suppose we ran insertion sort to sort this array in *ascending* order.

Select all the correct options from the list below.

- [x] After i steps, suppose the sorted portion is $[n-i+1, \ldots, n]$ and the element to be inserted is $(n-i)$. We will need to perform i swaps to ensure that $n-i$ is inserted in the correct place.

Correct

- [x] The total number of swaps is given by:

$$1 + 2 + \cdots + (n-1) = \frac{n(n-1)}{2}$$

Correct

- [ ] Consider a different array `a: [a1, a2, ..., an]` that satisfies the property that `a[i] < a[i+1]` for all but one place `a[j]` wherein `a[j] > a[j+1]`. Insertion sort as presented in lecture will run in $\Theta(n)$ time for such an "almost" ascending sorted array.