**Insertions: Mathematical Analysis**

**Simple Vector Using Arrays**

* Each insertion copies all previous elements into a new array of size (n + 1)
* Total Time for n insertions: 1 + 2 + 3 + ... + n =
* Average Time per insertion: \* = = O(n)

Proof: ≤ c \* n where c is a constant

= ≤ c = ≤ c

As N approaches ∞, approaches 0, so the left-hand side approaches

So, for all n ≥ 1, the left-hand side is always less than 1.

so: ≤ n for all n ≥ 1  **= O(n)**

**Optimized Simple Vector using arrays**

* Array capacity doubles when full.
* all copies for n insertions: 1 + 2 + 4 + 8 + ... + = geometric series = 2n - 1 = O(n)
* Average per insertion: = O(1)

**Simple Vector Using Linked List**

* Each insertion adds a node to the end
* Total Time for n insertions: n \* O(1) = O(n)