- Maximal Contiguous subsequence sum.

A. Big-Oh $O(n^3)$

- $\sum_{i=0}^{n-1} (\sum_{j=i}^{n-1} (\sum_{k=i}^{j} (1) + 2))$

  - $\sum_{k=i}^{j} (1) = j - i + 1$
    $= j - (i-1)$

- $\sum_{i=0}^{n-1} (\sum_{j=i}^{n-1} (j - (i-1) + 2))$

  $\sum_{i=0}^{n-1} (\sum_{j=i}^{n-1} (j - (i-3)))$

  - $\sum_{j=i}^{n-1} (j - (i-3)) = \sum_{j=i}^{n-1} (j) - \sum_{j=i}^{n-1} (i-3)$

$$= \left(\sum_{j=0}^{n-1} (j) - \sum_{j=0}^{i-1} (j)\right) - (i-3) \sum_{j=i}^{n-1} (1)$$

$$= \left(\frac{n(n-1)}{2} - \frac{i(i-1)}{2}\right) + (i-3)(i-n)$$

$$= \left(i^2 - in - 3i - \frac{i^2 - i}{2}\right) + 3n + \frac{n(n-1)}{2}$$

$$= \frac{i(i+1)}{2} - i(n+3) + 3n + \frac{n(n-1)}{2}$$

$$= \frac{i^2}{2} + \frac{i}{2} - i(n+3) + 3n + \frac{n(n-1)}{2}$$

$$= \frac{i^2}{2} - i(n + 5/2) + \frac{n(n+5)}{2}$$

- $\sum_{i=0}^{n-1} (i^2/2 - i(n+5/2) + n(n+5)/2)$

$$= (1/2) \sum_{i=0}^{n-1} (i^2) - (n+5/2) \sum_{i=0}^{n-1} (i) + (1/2)(n(n+5)) \sum_{i=0}^{n-1} (1)$$

$$= \frac{1}{2}\left(\frac{n(n-1)(2n-1)}{6}\right) - \frac{(n+5/2)(n)(n-1)}{2} + \frac{n^2(n+5)}{2}$$

$$= \frac{n(n-1)}{2}\left(\frac{2n-1}{6} - \frac{2n+5}{2}\right) + \frac{n^2(n+5)}{2}$$

$$C(n) = \frac{n(n^2+9n+8)}{6} \Rightarrow \frac{n^3}{6} \in O(n^3)$$

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Because best case, average case, worst case are irrelevant b/c entire array must be traversed all runs

$$\Theta(n^3) = O(n^3)$$

B. Big-Oh $O(n^2)$

- $\sum_{i=0}^{n-1} (\sum_{j=i}^{n-1} (2) + 1) =$

$$= \sum_{i=0}^{n-1} (2(n-1-i+1)+1)$$

$$= \sum_{i=0}^{n-1} (2(n-i)+1)$$

$$= \sum_{i=0}^{n-1} (2n+1) - \sum_{i=0}^{n-1} (2i)$$

$$= (2n+1) \sum_{i=0}^{n-1} (1) - 2\sum_{i=0}^{n-1} (i)$$

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

$$C(n) = n(n+2)$$

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$$C(n) = n(n+2)$$
$$= n^2 + 2n$$
$$\Rightarrow n^2 \in O(n^2)$$

C. Big-Oh $O(n)$

- $\sum_{i=0}^{n-1} (2) =$

$$= \sum_{i=0}^{n-1} (2)$$

$$= 2\sum_{i=0}^{n-1} (1)$$

$$C(n) = 2n$$

$$C(n) = 2n \Rightarrow n \in O(n)$$

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Cubed		
N	T(n)	T(N)/N^3
125	881300	0.4512256
250	2051700	0.1313088
500	14755200	0.1180416
1000	115616700	0.1156167
2000	790822500	0.098852813

- Because the function is of O(n^3), T(n) = c (n^3).
- Based on the data aquired, we use the empirical data point T(n) = 790822500ns when n = 2000 to find that the constant c = T(n)/n^3 = 0.0988.

Square		
N	T(n)	T(N)/N^2
25000	822245800	1.31559328
50000	3392653600	1.35706144
100000	13090112700	1.30901127
200000	20547614100	0.513690353
400000	35042271400	0.219014196
800000	1.20169E+11	0.187764

- The value of C is converging to a positive and tiny value, meaning our function is more like O(n) than O(n^2)

Linear		
N	T(n)	T(N)/N
100000	619300	6.193
200000	801700	4.0085
400000	968100	2.42025
800000	1418200	1.77275
1600000	5658000	3.53625
3200000	10044700	3.13896875
6400000	24527900	3.832484375