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Atividade de AED 2

Observação: Não consegui enviar pelo GDB, pois precisava de uma biblioteca para gerar os números aleatórios, então estou enviando os códigos pelo rust playground, espero que não haja problemas.

1. O garçom desastrado e a bandeja de copos

A. [Link para o rust playground](#)

Tempo gasto: 23 484 milissegundos

B. Cálculo do caso médio:

```
fn bubble_sort(self) -> (u32, u32) {
    let mut comparacoes = 0;
    let mut trocas = 0;

    for i in (0..self.len()).rev() {
        let trocas_antes = trocas;
        for j in 0..i {
            comparacoes += 1;
            if self[j] > self[j+1] {
                trocas += 1;
                self.swap(j, j+1);
            }
        }
        if trocas == trocas_antes { break; }
    }

    return (comparacoes, trocas);
}
```

Caso médio: média do tempo para K (1 to n) elementos ordenados.

$$T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} \left[\sum_{j=1}^n \left[1 + \sum_{i=1}^k 3 \right] \right] \rightarrow T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} \left[\sum_{j=1}^n \left[1 + 3 \sum_{i=1}^k 1 \right] \right] \rightarrow$$

$$T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} \left[\sum_{j=1}^n [1 + 3k] \right] \rightarrow T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} [n + 3kn] \rightarrow$$

$$T(n) = \frac{1}{n-1} \left[\frac{n(n-1)}{2} + \frac{3n^2(n-1)}{2} \right] \rightarrow T(n) = \frac{1}{O(n)} \left[O(n^2) + O(n^3) \right] \rightarrow$$

$$T(n) = O(n^2) + O(n) \quad ; \quad \text{Big } O = O(n^2)$$

2. O leiloeiro econômico

A. [Link para o rust playground](#)

Tempo gasto: 19 033 milissegundos

B. Cálculo do caso médio:

```
fn selection-sort(self) -> (u32, u32) {
    let mut comparações = 0;
    let mut trocas = 0;

    let mut menor;

    for i in 0..self.len() {
        menor = i;
        for j in i+1..self.len() {
            comparações += 1;
            if self[j] < self[menor] {
                menor = j;
            }
        }
        self.swap(menor, i);
        trocas += 1;
    }

    return (comparações, trocas);
}
```

Caso médio: média do tempo para K (1 to n) elementos ordenados

$$T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} \left[3 + \sum_{i=1}^n 2 + \sum_{j=i+1}^n 1 \right] \leftrightarrow T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} \left[3 + 2 \sum_{i=1}^n 1 + \sum_{j=1}^n 1 - \sum_{j=1}^i 1 \right] \rightarrow$$

$$T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} [3 + 2n^2 + n] \rightarrow T(n) = \frac{1}{n-1} \left[3 \sum_{k=1}^{n-1} 1 + 2 \sum_{k=1}^{n-1} n^2 + \sum_{k=1}^{n-1} n \right] \rightarrow$$

$$T(n) = \frac{1}{n-1} [2n^3 + n + 3] \rightarrow T(n) = \frac{1}{O(n)} [O(n^3) + O(n) + O(1)] \rightarrow T(n) = O(n^2) + O(1)$$

$$\text{Big } O = O(n^2)$$

3. O bibliotecário organizado

A. [Link para o rust playground](#)

Tempo gasto: 18 236 milissegundos

B. Cálculo do caso médio:

```
fn insertion-sort(self) -> (u32, u32) {  
    let mut comparacoes = 0;  
    let mut trocas = 0;  
  
    let mut k: u32;  
  
    for i in 1..self.len() {  
        k = i;  
        comparacoes += 1;  
        while k > 0 && self[k] < self[k-1] {  
            trocas += 1;  
            self.swap(k, k-1);  
            k -= 1;  
        }  
    }  
  
    return (comparacoes, trocas);  
}
```

Caso médio: Média do tempo para k (1 to n) elementos ordenados

$$T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} \left[3 + \sum_{j=2}^n \left[2 + \sum_{j=1}^k 3 \right] \right] \rightarrow T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} \left[3 + 2 \sum_{j=2}^n [1 + 3k] \right] \rightarrow$$

$$T(n) = \frac{1}{n-1} \sum_{k=1}^{n-1} [3 + 2 \cdot (3k+2)(n-1)] \rightarrow T(n) = \frac{1}{n-1} [3n^3 - 2n^2 - 2n + 1] \rightarrow$$

$$T(n) = \frac{1}{O(n)} [O(n^3) - O(n^2) - O(n) + O(1)] \rightarrow T(n) = O(n^2) - O(n) - O(1)$$

$$\text{Big } O = O(n^2)$$

4. Ordenação manual

A. Com selection sort:

[42,17,89,5,73,31,64,96,23,58,10,37,81,12,50] → [5,17,89,42,73,31,64,96,23,58,10,37,81,12,50]
[5,17,89,42,73,31,64,96,23,58,10,37,81,12,50] → [5,10,89,42,73,31,64,96,23,58,17,37,81,12,50]
[5,10,89,42,73,31,64,96,23,58,17,37,81,12,50] → [5,10,12,42,73,31,64,96,23,58,17,37,81,89,50]
[5,10,12,42,73,31,64,96,23,58,17,37,81,89,50] → [5,10,12,17,73,31,64,96,23,58,42,37,81,89,50]
[5,10,12,17,73,31,64,96,23,58,42,37,81,89,50] → [5,10,12,17,23,31,64,96,73,58,42,37,81,89,50]
[5,10,12,17,23,31,64,96,73,58,42,37,81,89,50] → [5,10,12,17,23,31,64,96,73,58,42,37,81,89,50]
[5,10,12,17,23,31,64,96,73,58,42,37,81,89,50] → [5,10,12,17,23,31,37,96,73,58,42,64,81,89,50]
[5,10,12,17,23,31,37,96,73,58,42,64,81,89,50] → [5,10,12,17,23,31,37,42,73,58,96,64,81,89,50]
[5,10,12,17,23,31,37,42,73,58,96,64,81,89,50] → [5,10,12,17,23,31,37,42,50,58,96,64,81,89,73]
[5,10,12,17,23,31,37,42,50,58,96,64,81,89,73] → [5,10,12,17,23,31,37,42,50,58,96,64,81,89,73]
[5,10,12,17,23,31,37,42,50,58,96,64,81,89,73] → [5,10,12,17,23,31,37,42,50,58,64,96,81,89,73]
[5,10,12,17,23,31,37,42,50,58,64,96,81,89,73] → [5,10,12,17,23,31,37,42,50,58,64,73,81,89,96]
[5,10,12,17,23,31,37,42,50,58,64,73,81,89,96] → [5,10,12,17,23,31,37,42,50,58,64,73,81,89,96]
[5,10,12,17,23,31,37,42,50,58,64,73,81,89,96] → [5,10,12,17,23,31,37,42,50,58,64,73,81,89,96]

B. Com Insertion sort:

[42,17,89,5,73,31,64,96,23,58,10,37,81,12,50] → [17,42,89,5,73,31,64,96,23,58,10,37,81,12,50]
[17,42,89,5,73,31,64,96,23,58,10,37,81,12,50] → [17,42,89,5,73,31,64,96,23,58,10,37,81,12,50]
[17,42,89,5,73,31,64,96,23,58,10,37,81,12,50] → [5,17,42,89,73,31,64,96,23,58,10,37,81,12,50]
[5,17,42,89,73,31,64,96,23,58,10,37,81,12,50] → [5,17,42,73,89,31,64,96,23,58,10,37,81,12,50]
[5,17,42,73,89,31,64,96,23,58,10,37,81,12,50] → [5,17,31,42,73,89,64,96,23,58,10,37,81,12,50]
[5,17,31,42,73,89,64,96,23,58,10,37,81,12,50] → [5,17,31,42,64,73,89,96,23,58,10,37,81,12,50]
[5,17,31,42,64,73,89,96,23,58,10,37,81,12,50] → [5,17,31,42,64,73,89,96,23,58,10,37,81,12,50]
[5,17,31,42,64,73,89,96,23,58,10,37,81,12,50] → [5,17,23,31,42,64,73,89,96,58,10,37,81,12,50]
[5,17,23,31,42,64,73,89,96,58,10,37,81,12,50] → [5,17,23,31,42,58,64,73,89,96,10,37,81,12,50]
[5,17,23,31,42,58,64,73,89,96,10,37,81,12,50] → [5,10,17,23,31,42,58,64,73,89,96,37,81,12,50]
[5,10,17,23,31,42,58,64,73,89,96,37,81,12,50] → [5,10,17,23,31,37,42,58,64,73,89,96,81,12,50]
[5,10,17,23,31,37,42,58,64,73,89,96,81,12,50] → [5,10,17,23,31,37,42,58,64,73,81,89,96,12,50]
[5,10,17,23,31,37,42,58,64,73,81,89,96,12,50] → [5,10,12,17,23,31,37,42,58,64,73,81,89,96,50]
[5,10,12,17,23,31,37,42,58,64,73,81,89,96,50] → [5,10,12,17,23,31,37,42,50,58,64,73,81,89,96]