Goals

• Be able to execute insertion sort and selection sort on paper.

• Be prepared to implement insertion sort and selection sort.
Why are we talking about sorting, I thought this was a data structures course?

(not sorted)  (sorted)

<table>
<thead>
<tr>
<th></th>
<th>PilingDrawer</th>
<th>FilingDrawer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add</td>
<td>O(1)</td>
<td>O(N)</td>
</tr>
<tr>
<td>Find</td>
<td>O(N)</td>
<td>O(log N)</td>
</tr>
</tbody>
</table>
Insertion Sort

Insert $A[i]$ into the sorted sublist $A[0..i-1]$.

Selection Sort

Find the smallest element in $A[i..n]$ and place it at $A[i]$.

Demo: [https://visualgo.net/bn/sorting](https://visualgo.net/bn/sorting)
Insertion Sort

Insert $A[i]$ into the sorted sublist $A[0..i-1]$.

Invariant: $\overline{A_{sorted\ ?}}$

Selection Sort

Find the smallest element in $A[i..n]$ and place it at $A[i]$.

Invariant: $\overline{A_{sorted, \ <= \ A[i..n]\ ?}}$
insertionSort(A):
  i = 0;
  while i < A.length:
    // bubble A[i] to its sorted position by repeatedly
    //   swapping with the element to its left
    // increment i
    i
  
Invariant: A sorted

selectionSort(A):
  i = 0;
  while i < A.length:
    // find minimum value in A[i..A.length]
    // swap it with A[i]
    // increment i
    i
  
Invariant: A sorted, <= A[i..n]

Demo: https://visualgo.net/bn/sorting
Developing Insertion Sort

Insert $A[i]$ into the sorted sublist $A[0..i-1]$.

Pre: 

$$A \begin{array}{c|c|c} \hline j & \vdots & \ ? \ \hline \end{array}$$

sorted

Invariant: 

$$A \begin{array}{c|c|c} \hline \text{sorted} & j & \ ? \ \hline \end{array}$$

Post: 

$$A \begin{array}{c|c|c} \hline \text{sorted} \ \hline \end{array}$$

$i = A\. \text{length}$
\[ i = 1 \]

While \( i < A \cdot \text{length} \):

\[ j = i \]

While \( (j > 0 \text{ and } A[j-1] > A[j]) \)

\[ \text{swap}(A, j, j-1) \]

\[ j-- \]

\[ i++ \]