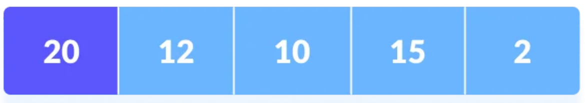
Selection Sort Algorithm

In this tutorial, you will learn about the selection sort algorithm and its implementation in Python, Java, C, and C++.

Selection sort is a sorting algorithm that selects the smallest element from an unsorted list in each iteration and places that element at the beginning of the unsorted list.

Working of Selection Sort

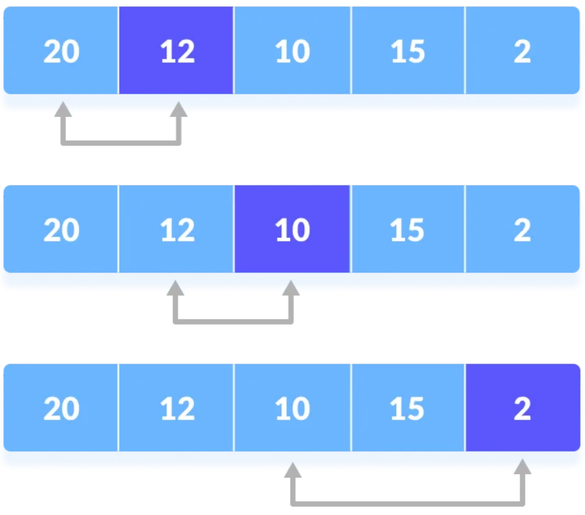
1. Set the first element as `minimum`.



Select first element as minimum

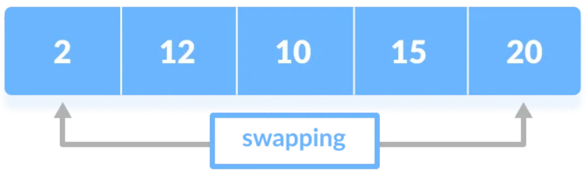
2. Compare `minimum` with the second element. If the second element is smaller than `minimum`, assign the second element as `minimum`.

   Compare `minimum` with the third element. Again, if the third element is smaller, then assign `minimum` to the third element otherwise do nothing. The process goes on until the last element.



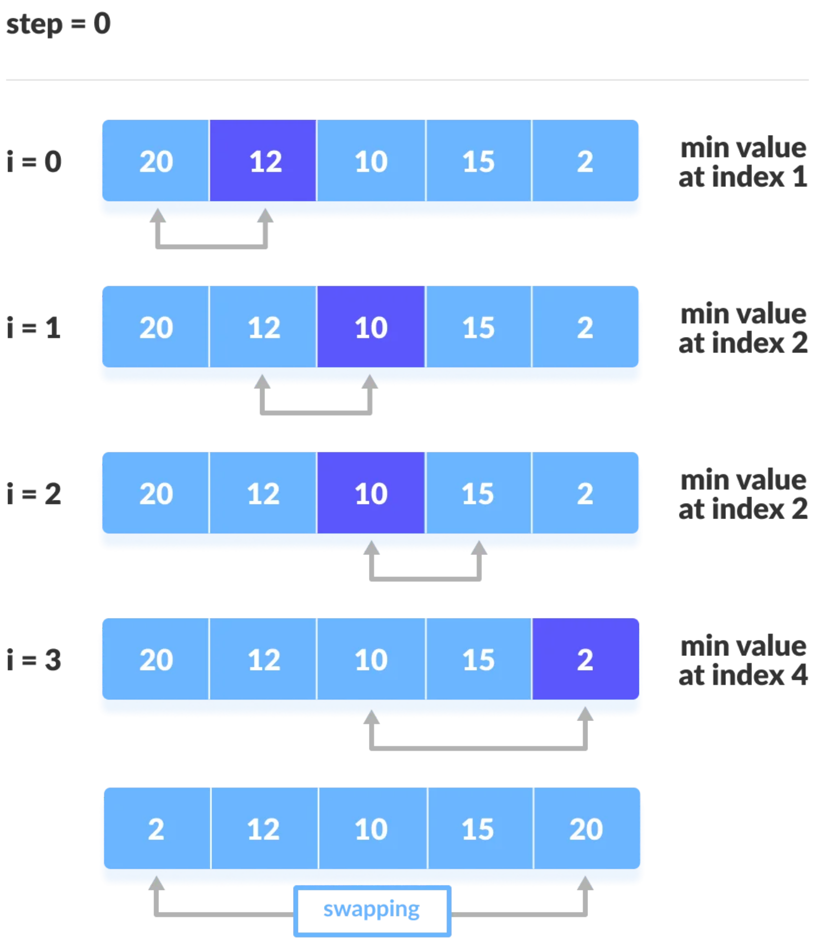
Compare minimum with the remaining elements

3. After each iteration, `minimum` is placed in the front of the unsorted list.

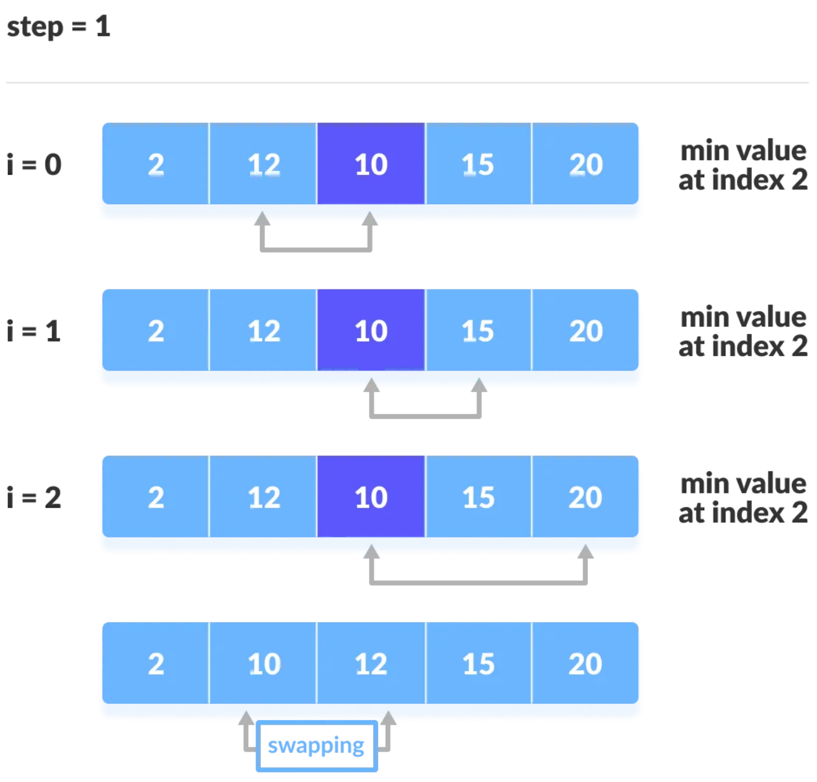


Swap the first with minimum

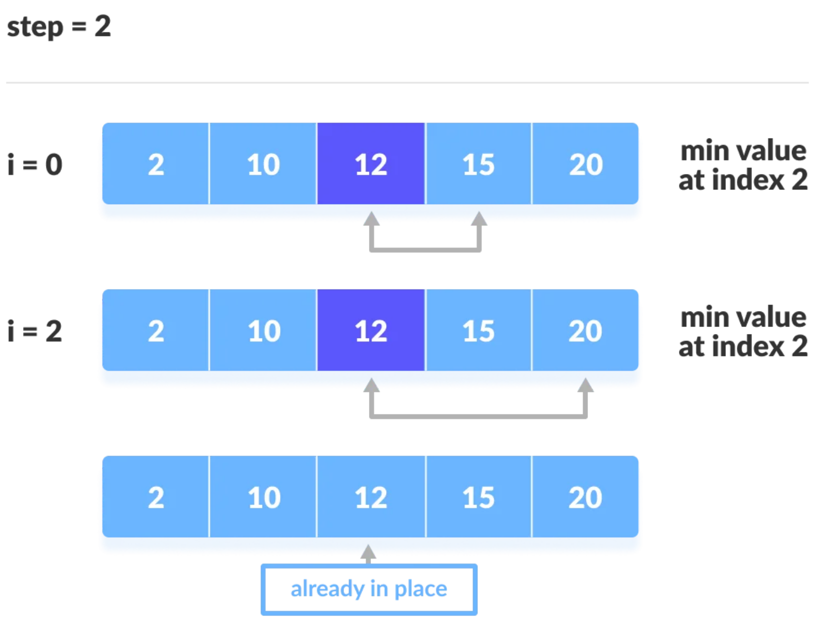
4. For each iteration, indexing starts from the first unsorted element. Step 1 to 3 are repeated until all the elements are placed at their correct positions.



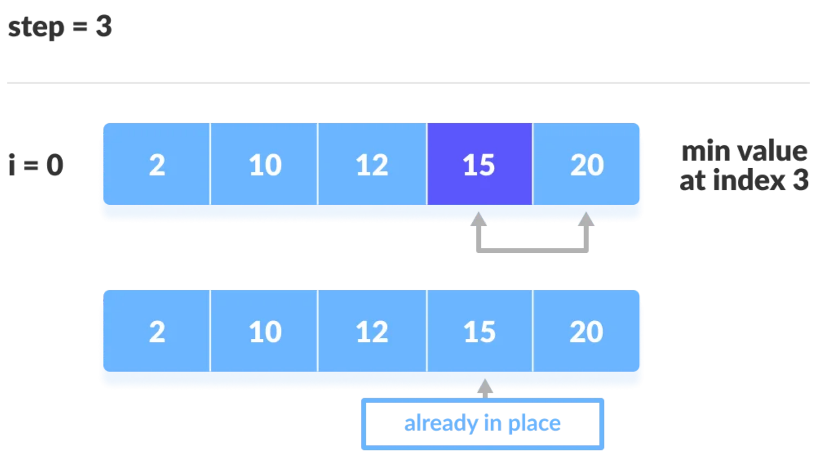
The first iteration



The second iteration



The third iteration



The fourth iteration

Selection Sort Algorithm

```
selectionSort(array, size)
  repeat (size - 1) times
  set the first unsorted element as the minimum
  for each of the unsorted elements
    if element < currentMinimum
      set element as new minimum
  swap minimum with first unsorted position
end selectionSort
```

Selection Sort Code in Python, Java, and C/C++

Python Java C C++

```
// Selection sort in C

#include <stdio.h>

// function to swap the the position of two elements
void swap(int *a, int *b) {
  int temp = *a;
  *a = *b;
  *b = temp;
}

void selectionSort(int array[], int size) {
  for (int step = 0; step < size - 1; step++) {
    int min_idx = step;
    for (int i = step + 1; i < size; i++) {

      // To sort in descending order, change > to < in this line.
      // Select the minimum element in each loop.
      if (array[i] < array[min_idx])
        min_idx = i;
    }

    // put min at the correct position
    swap(&array[min_idx], &array[step]);
  }
}

// function to print an array
```

Selection Sort Complexity

Time Complexity	
Best	$O(n^2)$
Worst	$O(n^2)$
Average	$O(n^2)$
Space Complexity	$O(1)$
Stability	No

Cycle	Number of Comparison
1st	(n-1)
2nd	(n-2)
3rd	(n-3)
...	...
last	1

Number of comparisons: `(n - 1) + (n - 2) + (n - 3) + ..... + 1 = n(n - 1) / 2` nearly equals to n^2.

Complexity = $O(n^2)$

Also, we can analyze the complexity by simply observing the number of loops. There are 2 loops so the complexity is $n*n = n^2$.

Time Complexities:

- **Worst Case Complexity:** $O(n^2)$
  If we want to sort in ascending order and the array is in descending order then, the worst case occurs.
- **Best Case Complexity:** $O(n^2)$
  It occurs when the array is already sorted
- **Average Case Complexity:** $O(n^2)$
  It occurs when the elements of the array are in jumbled order (neither ascending nor descending).

The time complexity of the selection sort is the same in all cases. At every step, you have to find the minimum element and put it in the right place. The minimum element is not known until the end of the array is not reached.

Space Complexity:

Space complexity is `O(1)` because an extra variable `temp` is used.

Selection Sort Applications

The selection sort is used when

- a small list is to be sorted
- cost of swapping does not matter
- checking of all the elements is compulsory
- cost of writing to a memory matters like in flash memory (number of writes/swaps is `O(n)` as compared to $O(n^2)$ of bubble sort)