CSC212

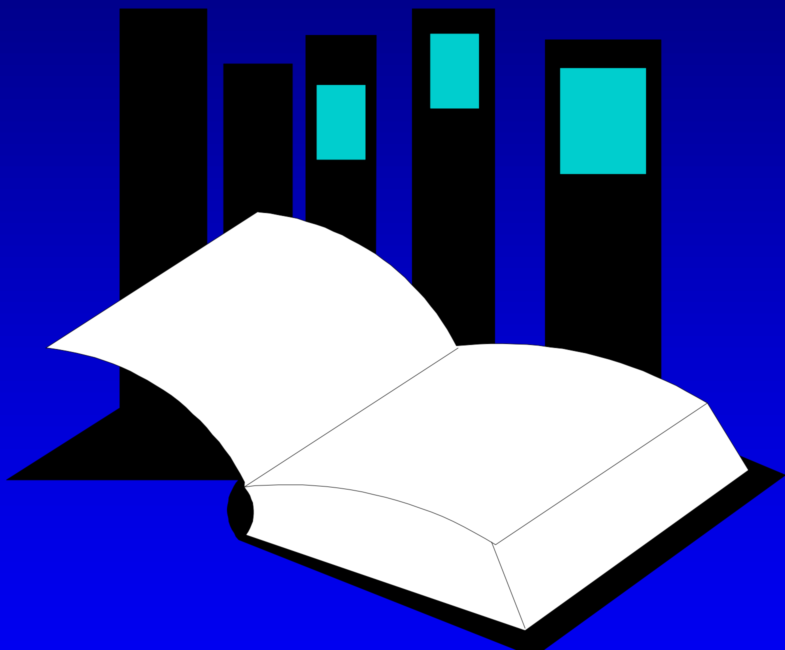
Data Structure

Lecture 20

Quadratic Sorting

Instructor: George Wolberg
Department of Computer Science
City College of New York

Quadratic Sorting

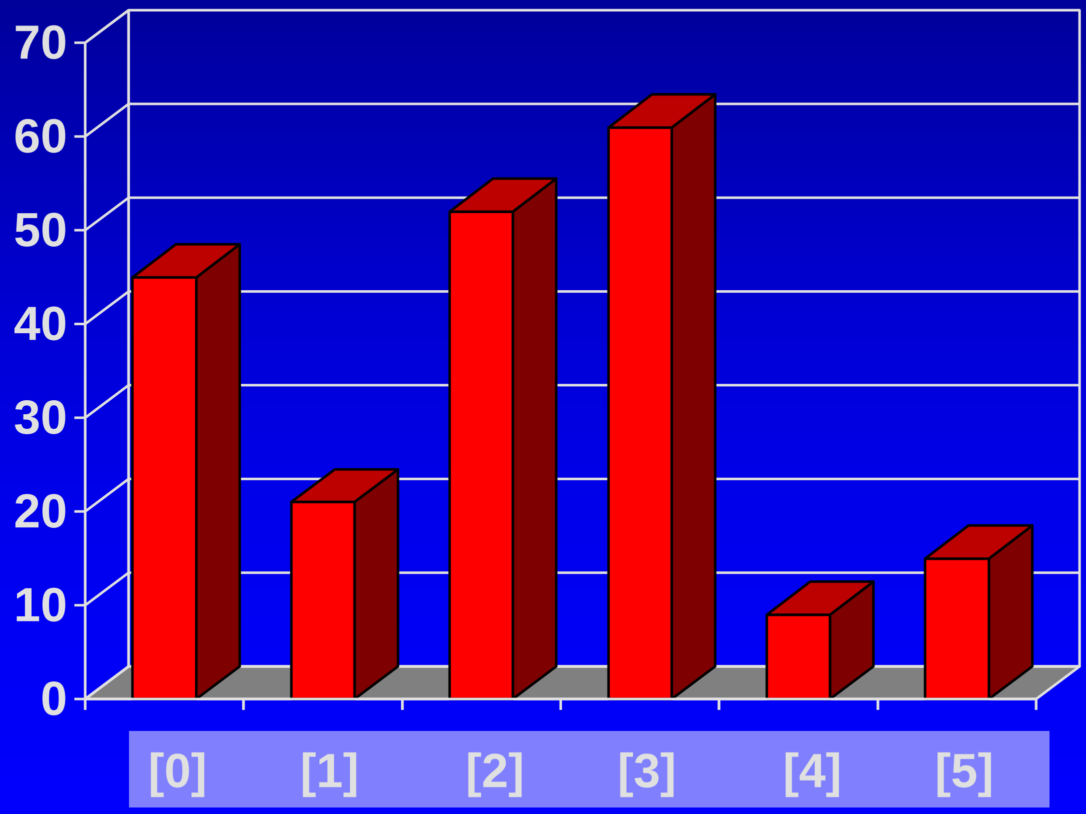


Data Structures and Other Objects Using C++

- Chapter 13 presents several common algorithms for sorting an array of integers.
- Two slow but simple algorithms are **Selectionsort** and **Insertionsort**.
- This presentation demonstrates how the two algorithms work.

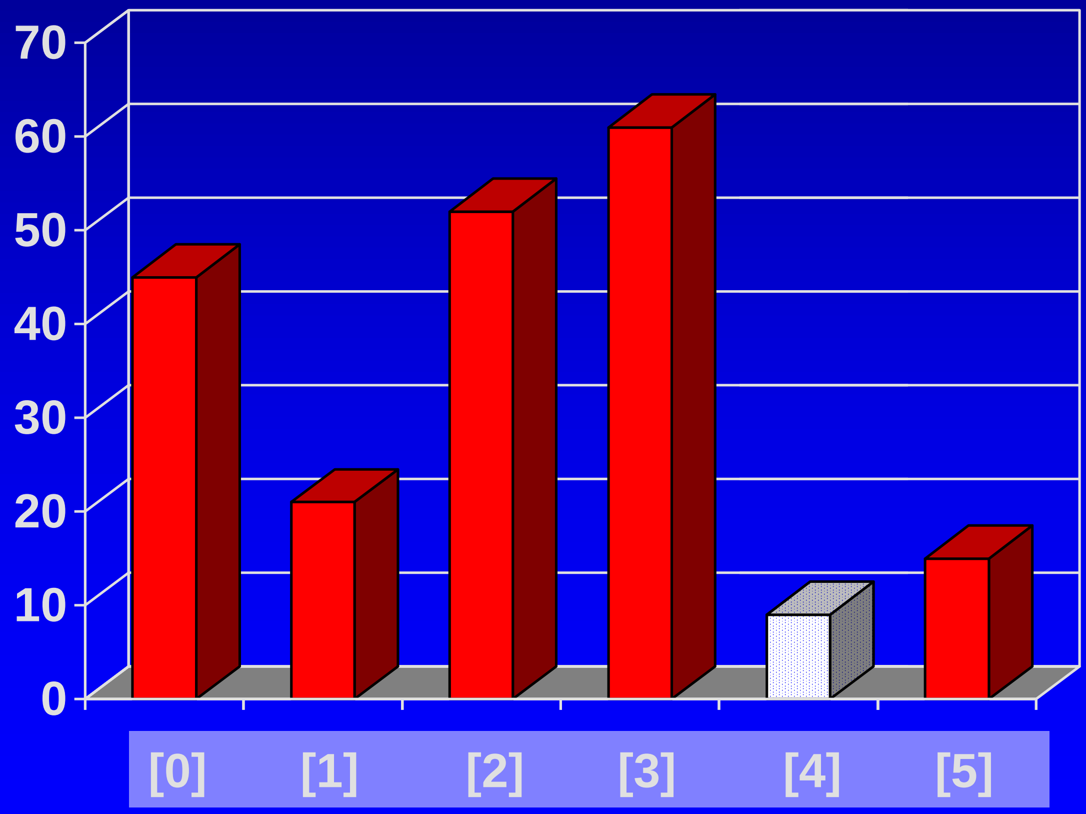
Sorting an Array of Integers

- The picture shows an array of six integers that we want to sort from smallest to largest



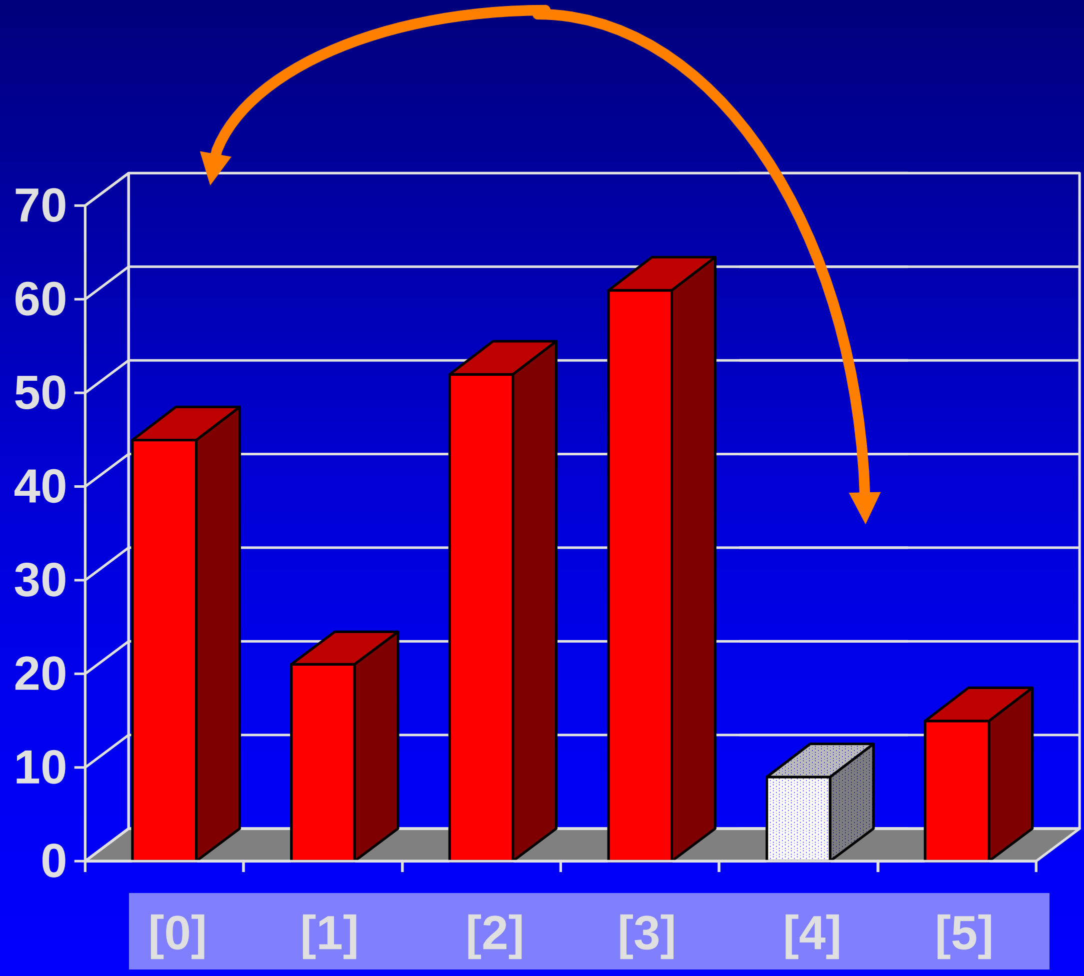
The Selectionsort Algorithm

- Start by finding the **smallest** entry.



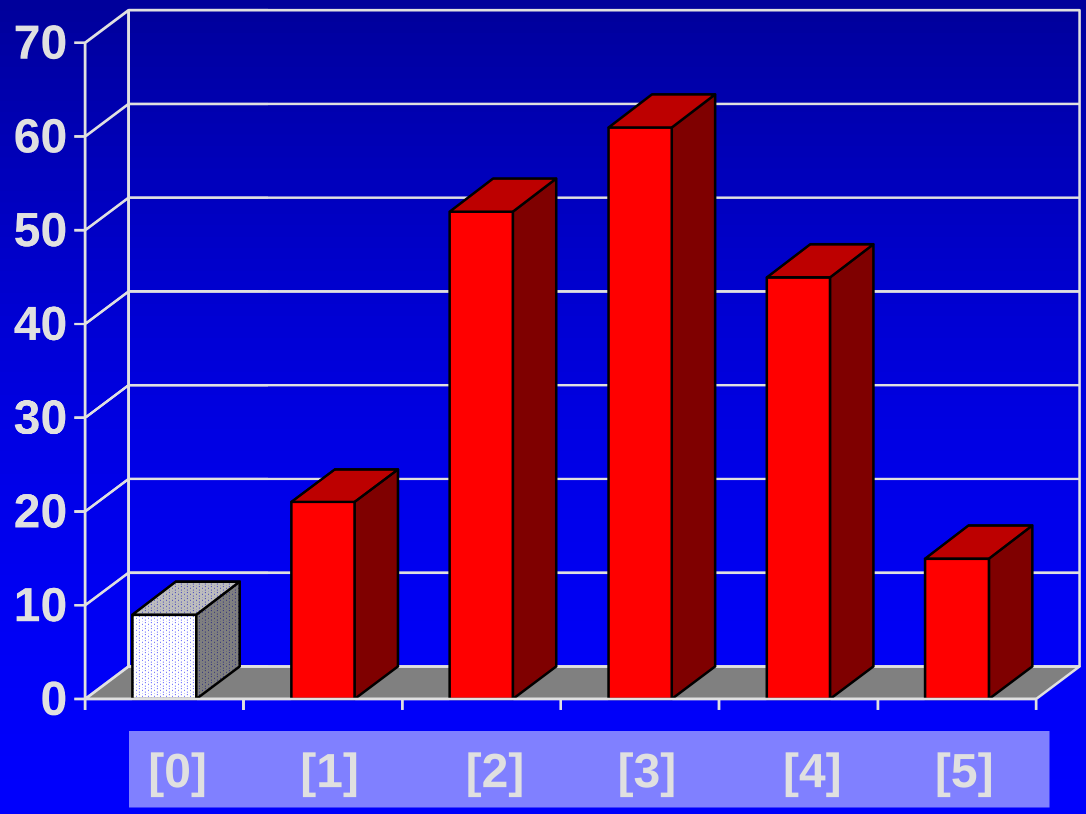
The Selectionsort Algorithm

- Start by finding the **smallest** entry.
- Swap the smallest entry with the **first entry**.



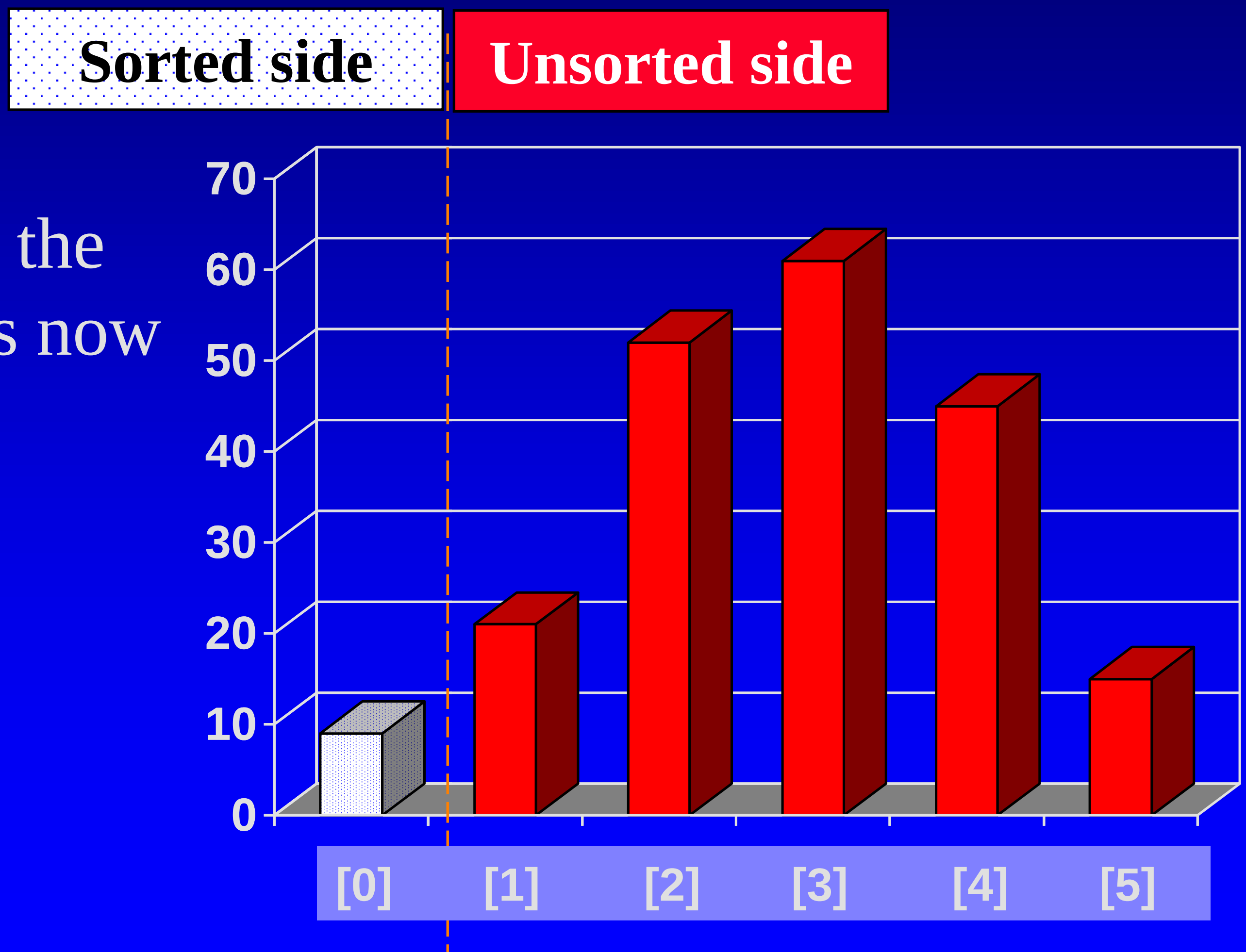
The Selectionsort Algorithm

- Start by finding the **smallest** entry.
- Swap the smallest entry with the **first entry**.



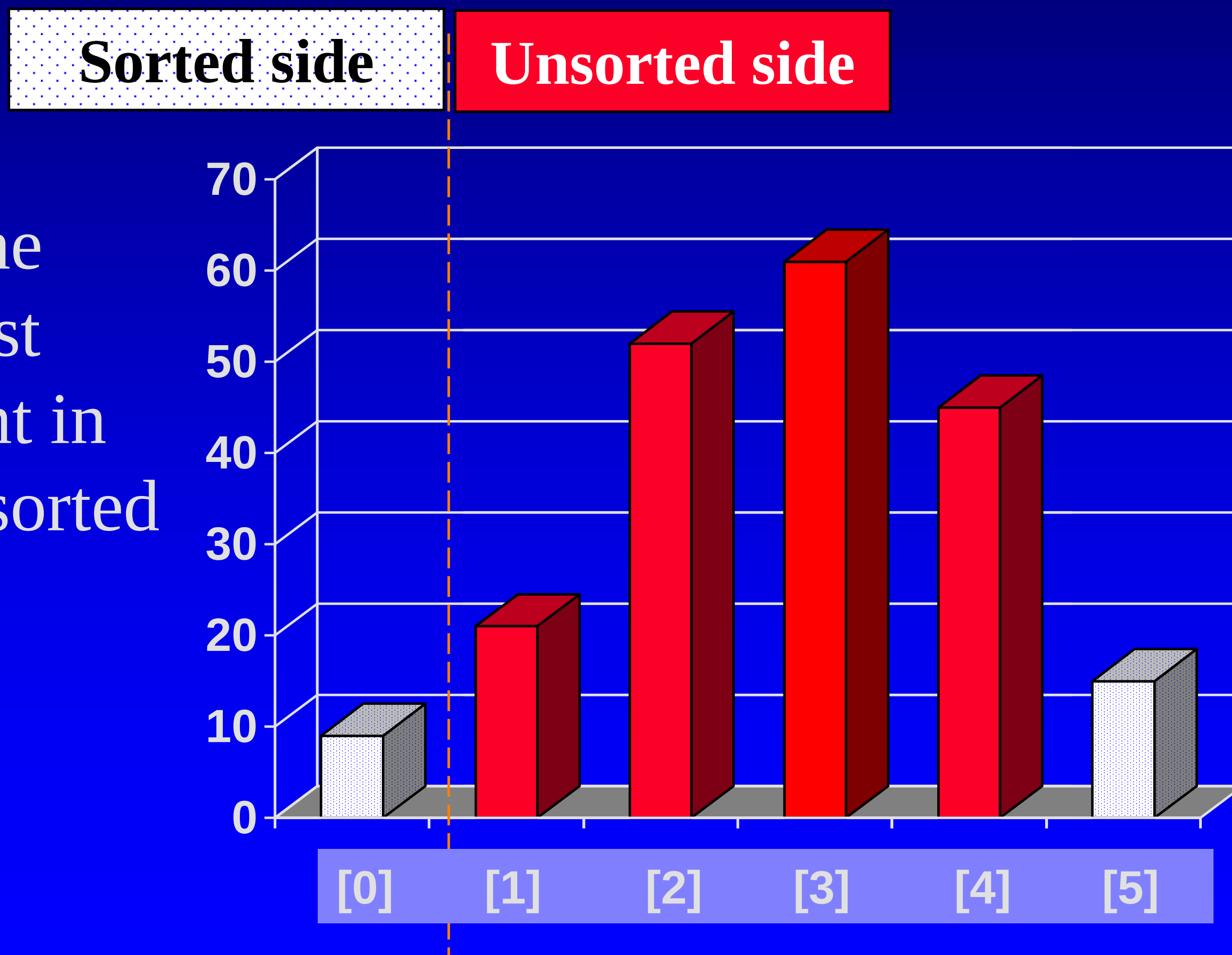
The Selectionsort Algorithm

- Part of the array is now sorted.

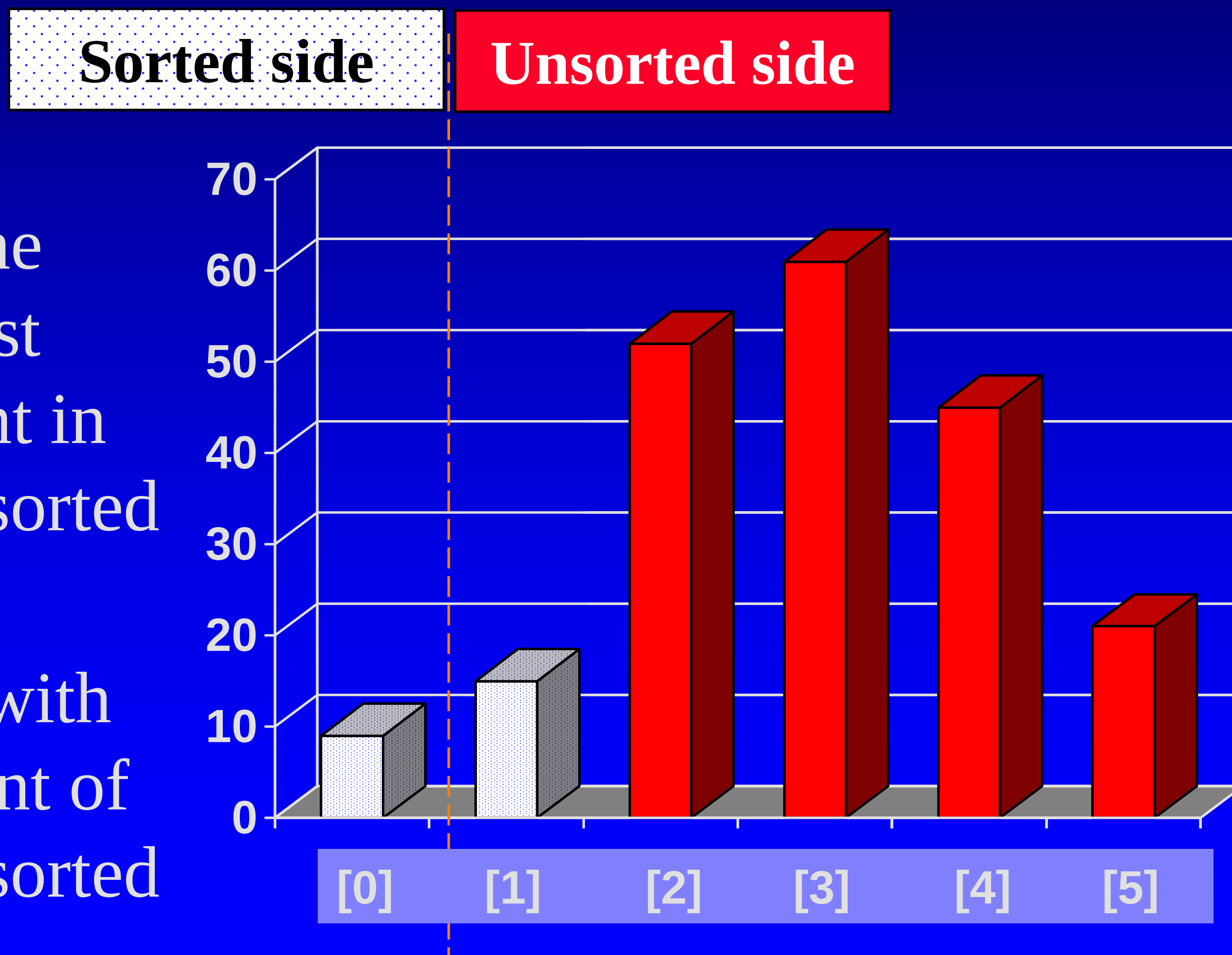


The Selectionsort Algorithm

- Find the smallest element in the unsorted side.



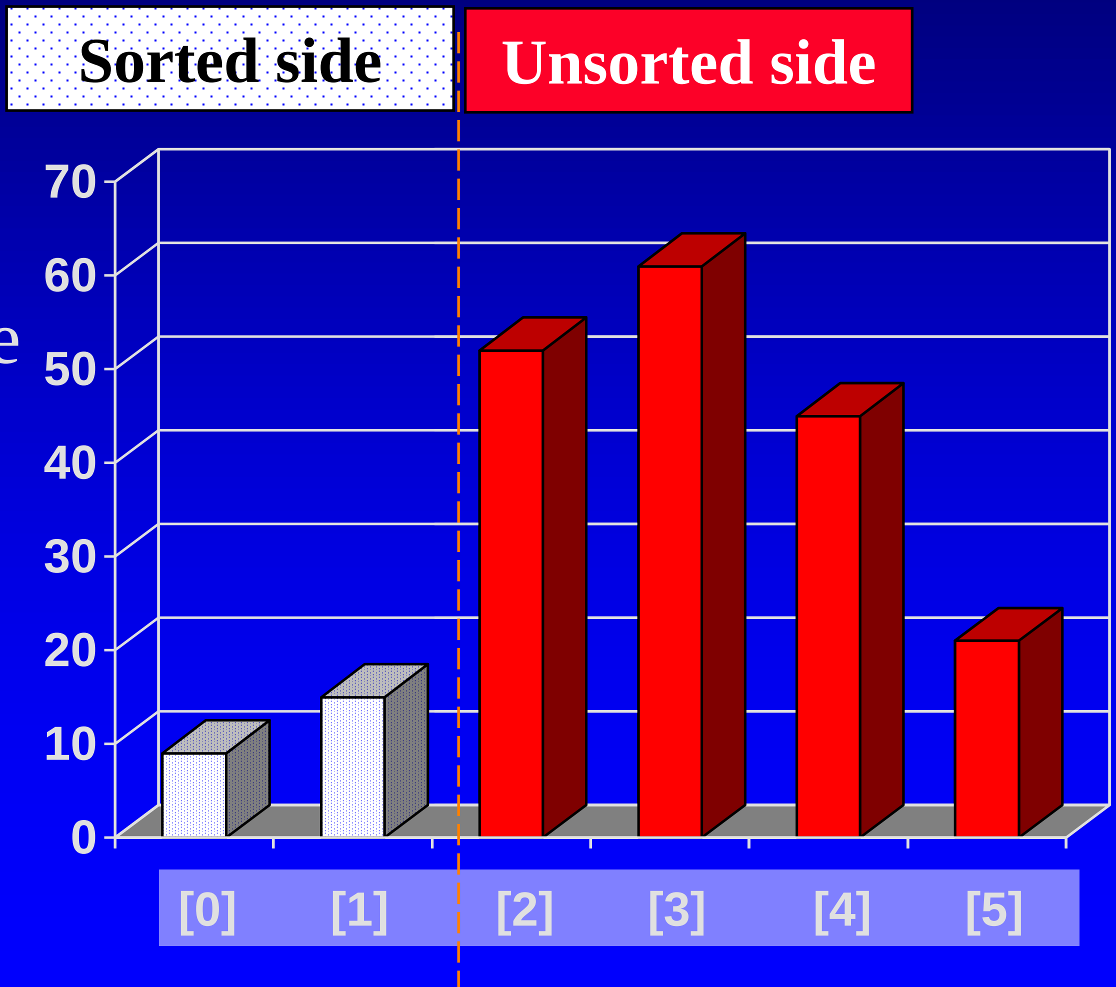
The Selectionsort Algorithm



- Find the smallest element in the unsorted side.
- Swap with the front of the unsorted side.

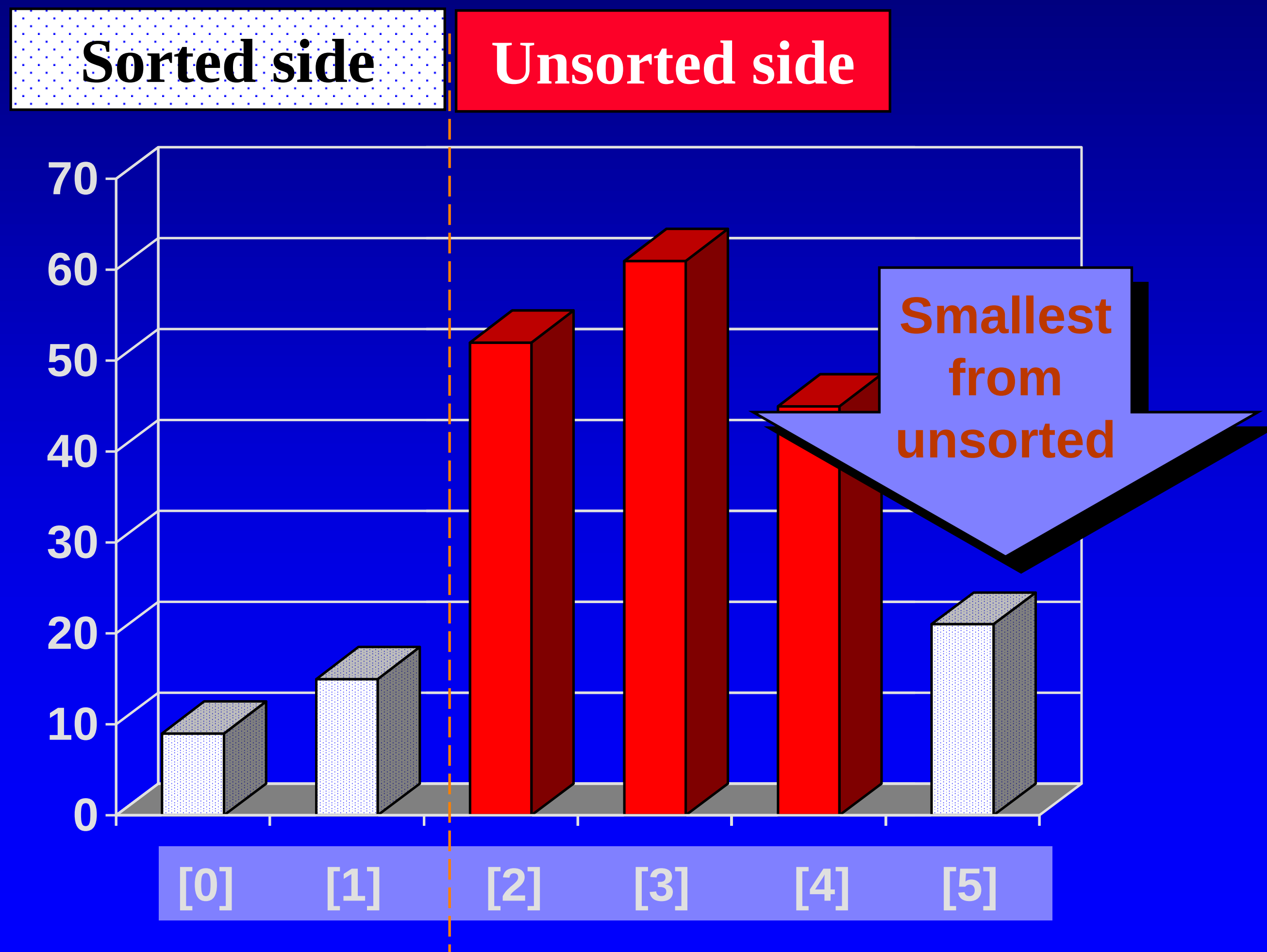
The Selectionsort Algorithm

- We have increased the size of the sorted side by one element.



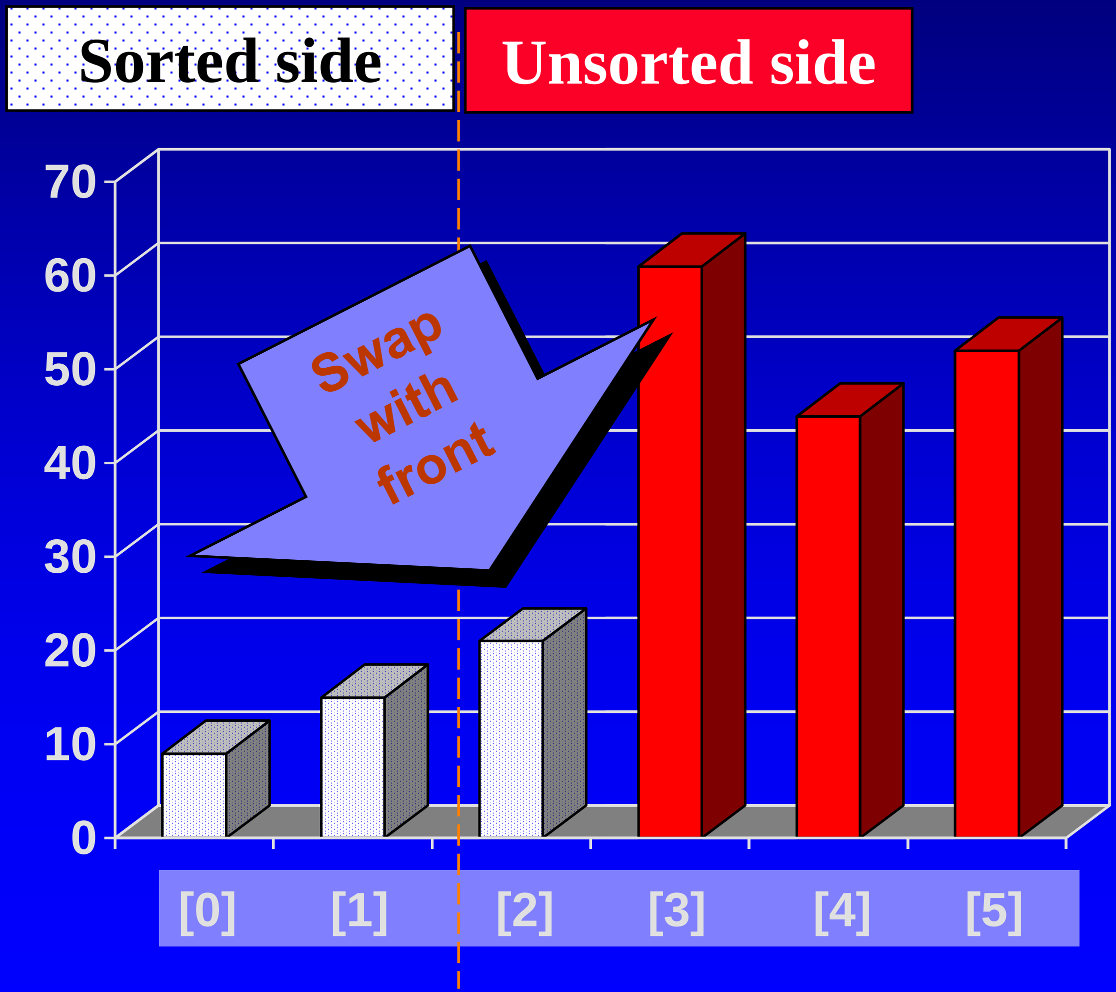
The Selectionsort Algorithm

- The process continues...



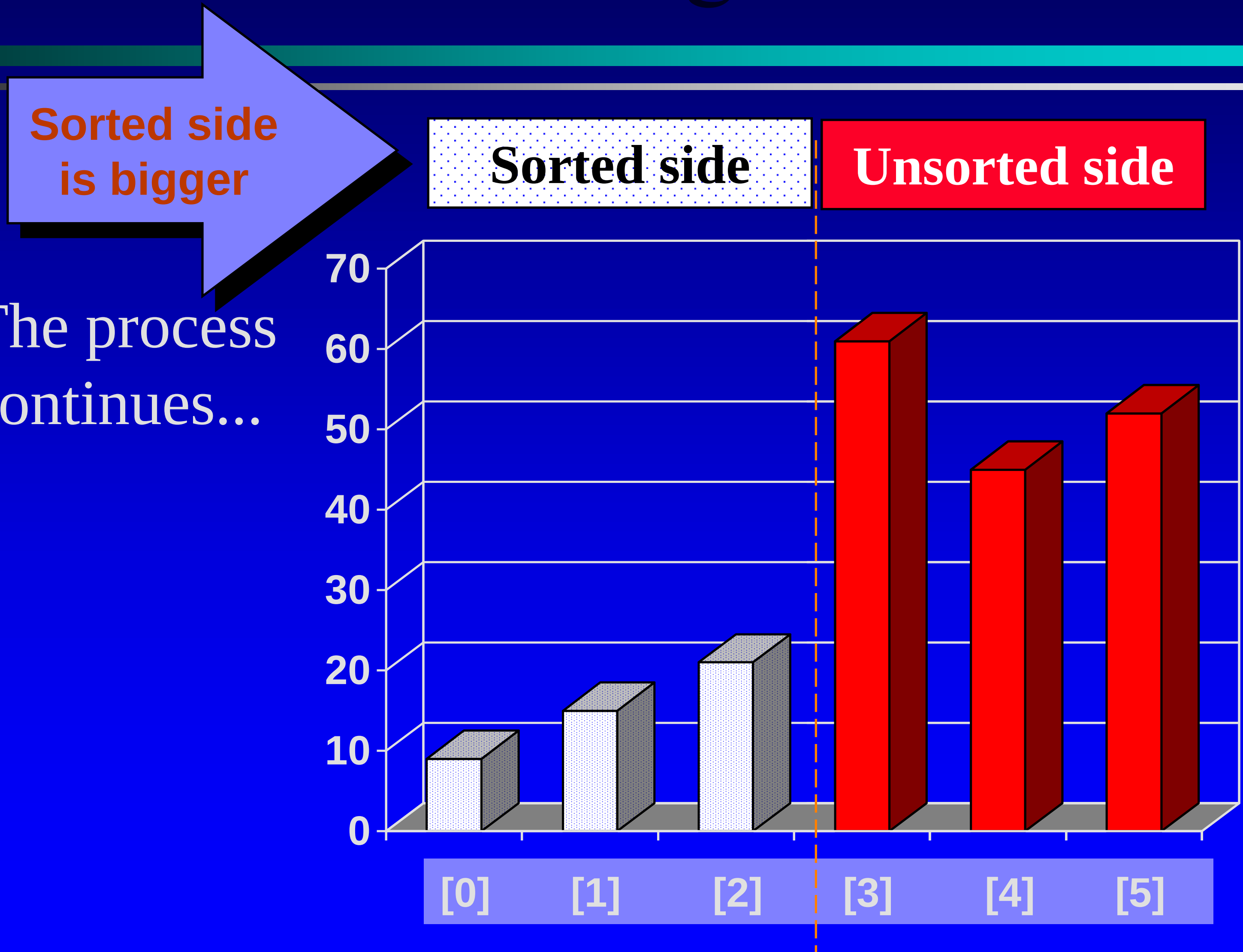
The Selectionsort Algorithm

- The process continues...



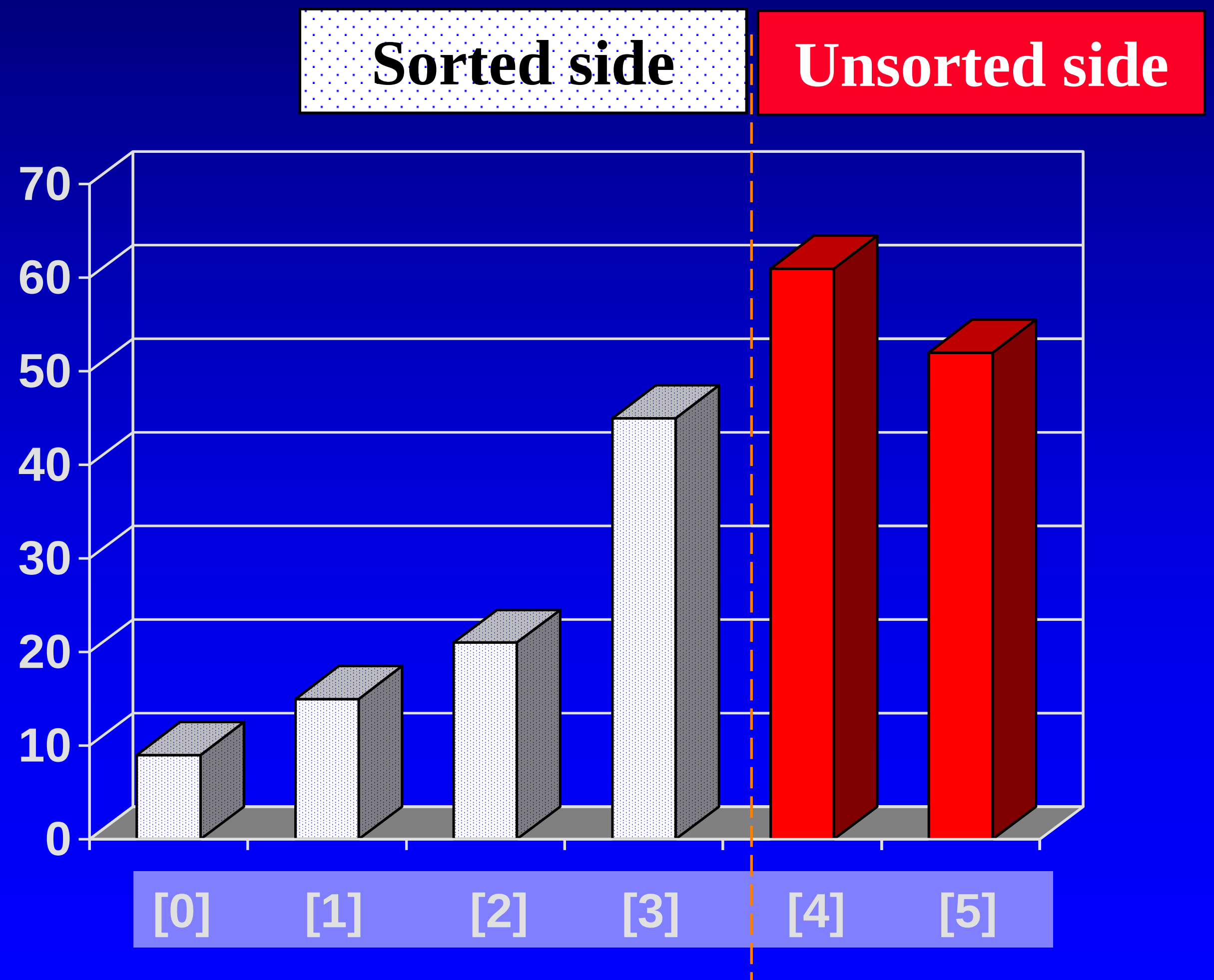
The Selectionsort Algorithm

- The process continues...



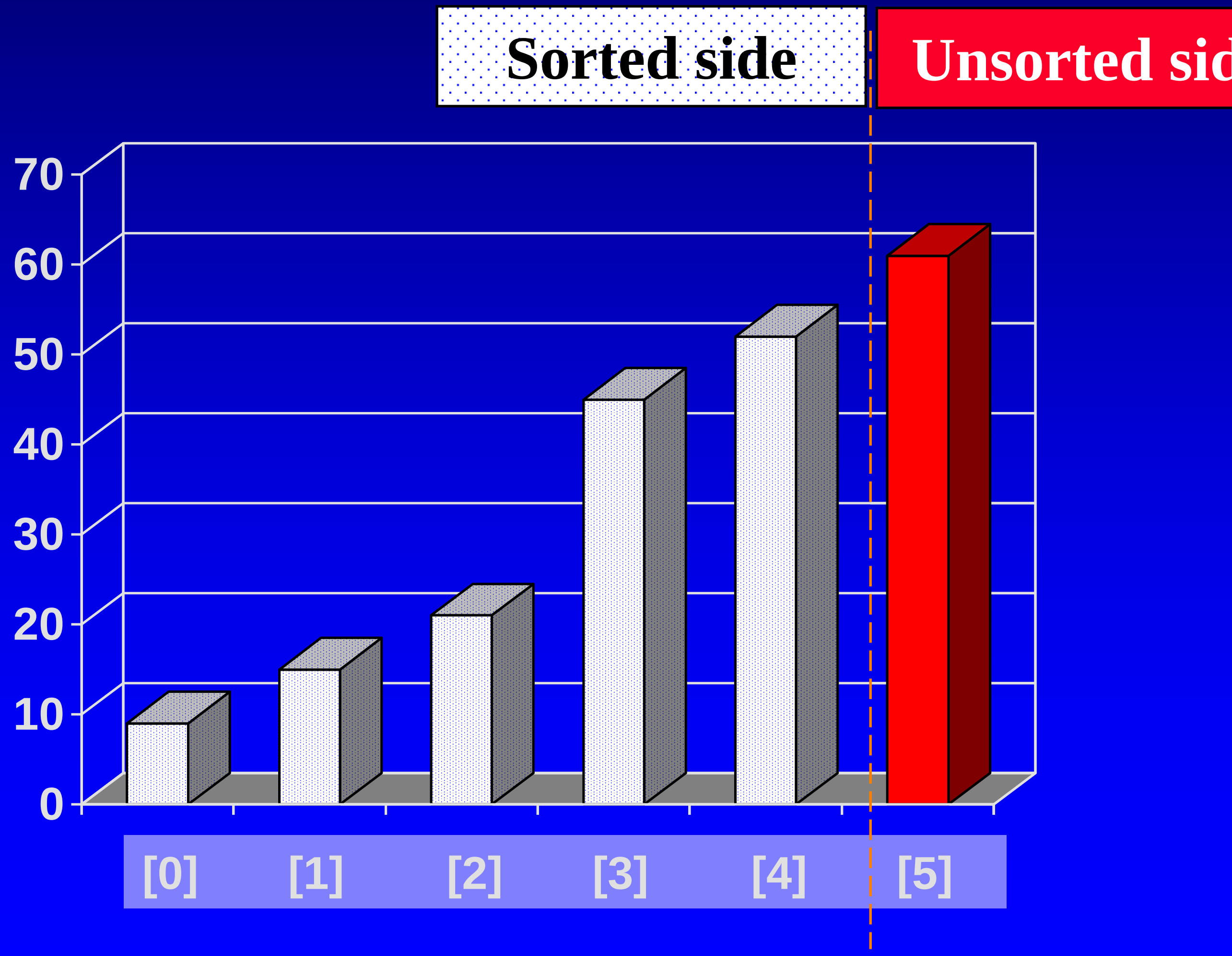
The Selectionsort Algorithm

- The process keeps adding one more number to the sorted side.
- The sorted side has the smallest numbers, arranged from small to large.



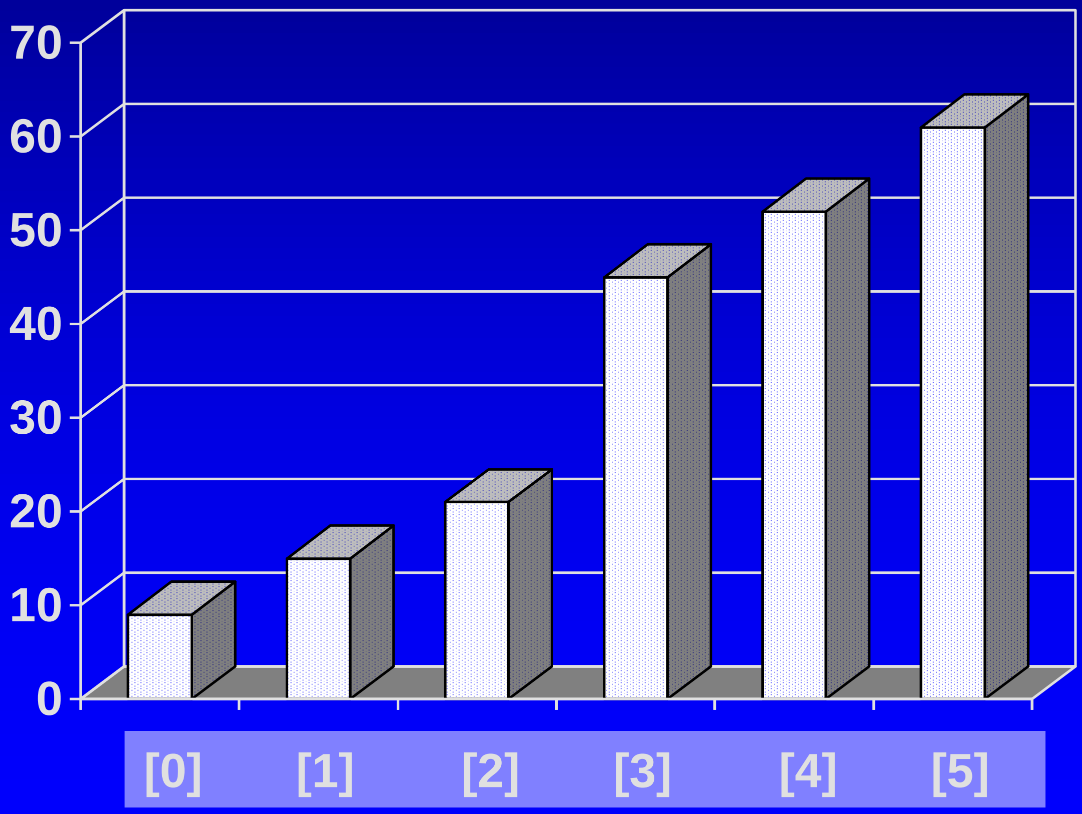
The Selectionsort Algorithm

- We can stop when the unsorted side has just one number, since that number must be the largest number.



The Selectionsort Algorithm

- The array is now sorted.
- We repeatedly **selected** the smallest element, and moved this element to the front of the unsorted side.

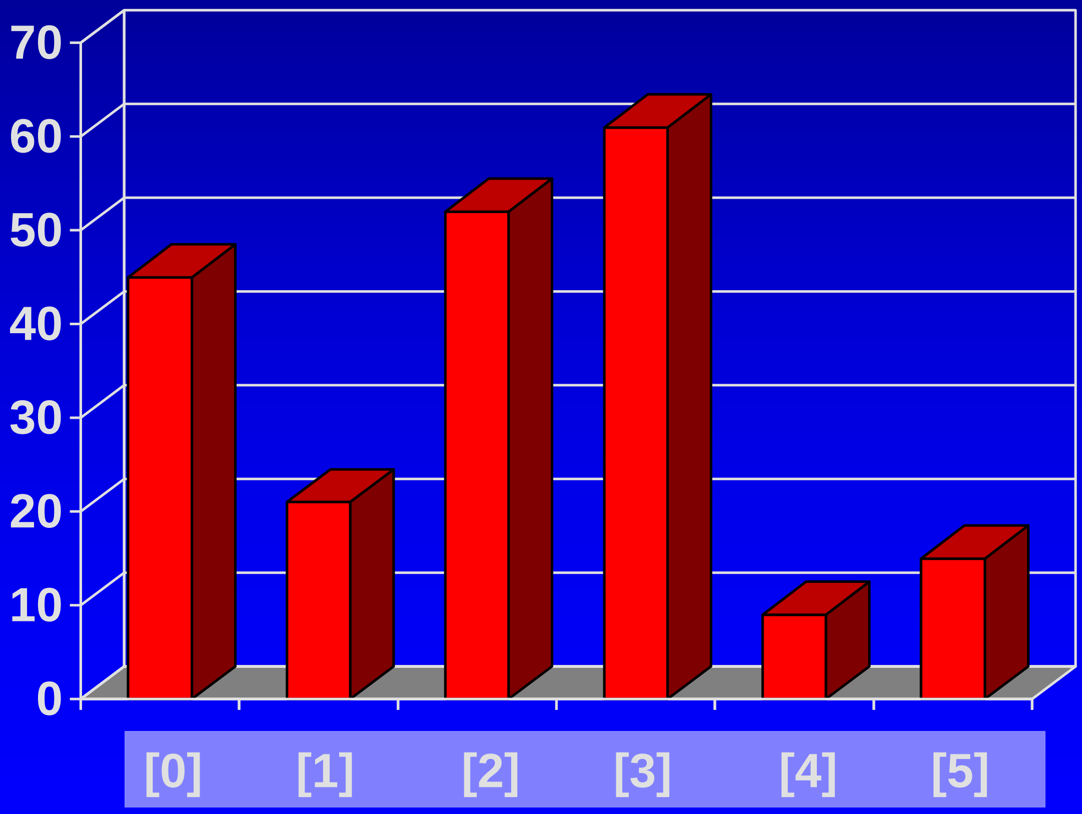


The Selectionsort Algorithm

- Question 1:
  - Can you write out the code?
- Question 2:
  - What is the Big-O of the selectionsort algorithm?
- Question 3:
  - Best case, worst case and average case
  - deterministic?

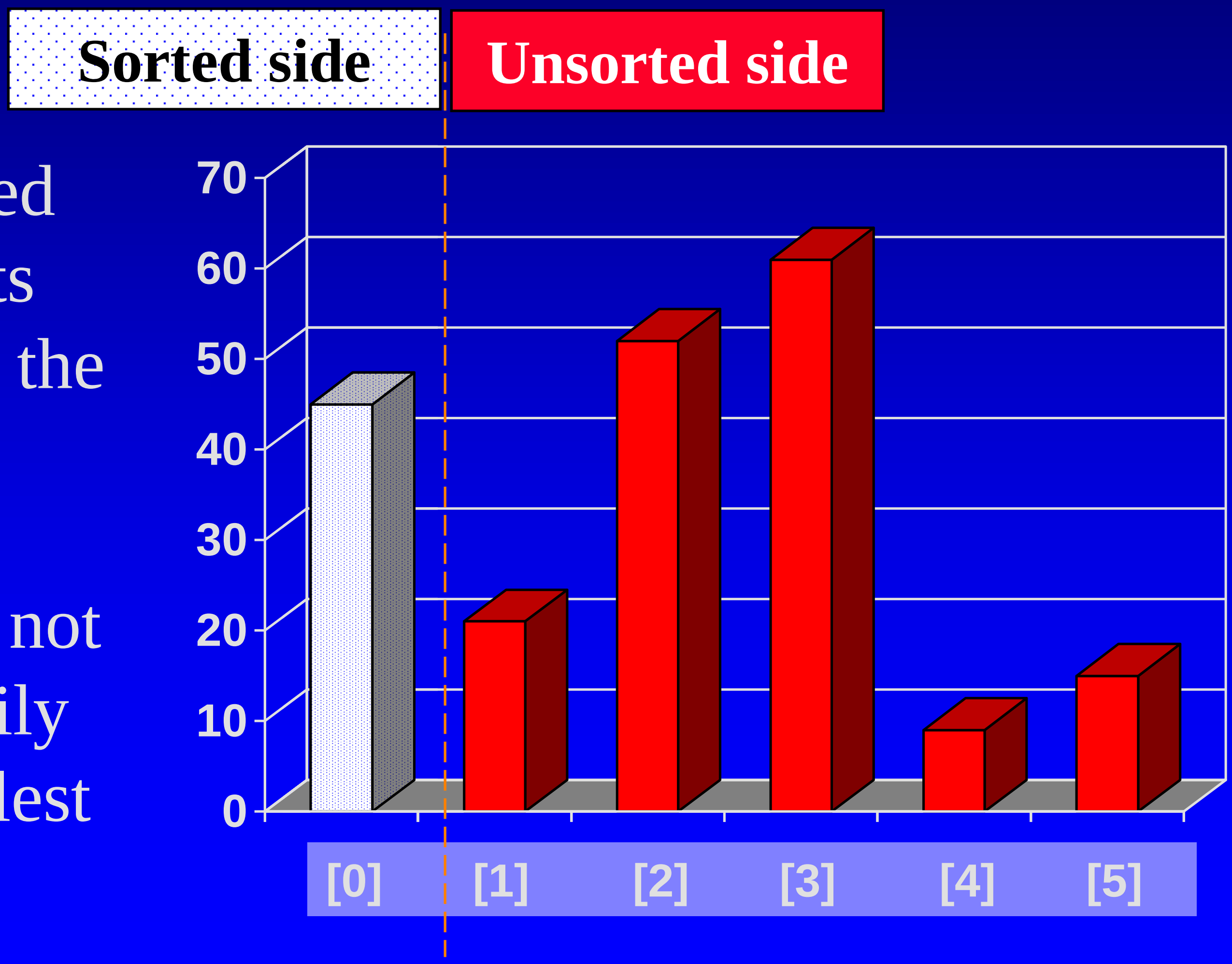
The Insertionsort Algorithm

- The Insertionsort algorithm also views the array as having a sorted side and an unsorted side.



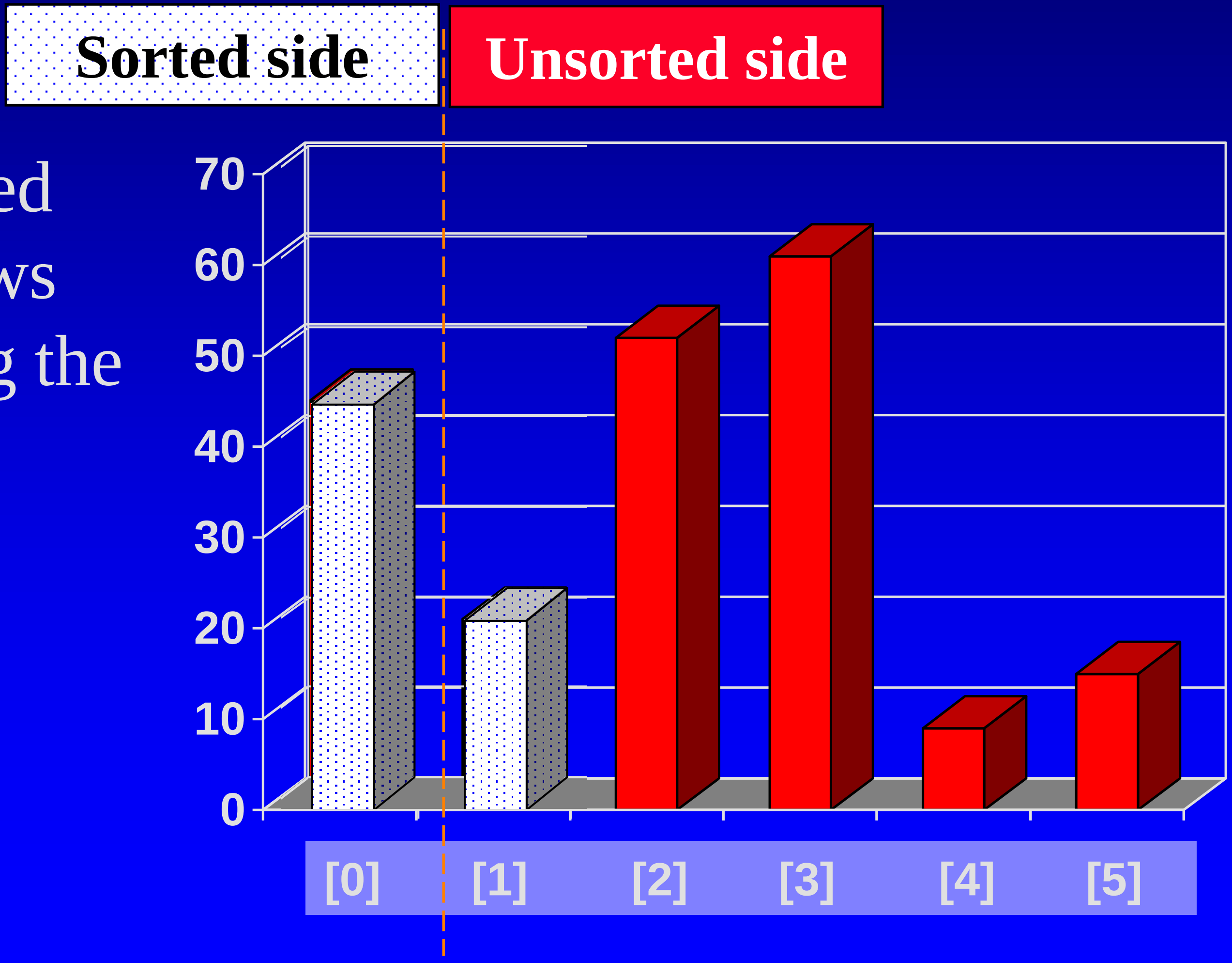
The Insertionsort Algorithm

- The sorted side starts with just the first element, which is not necessarily the smallest element.



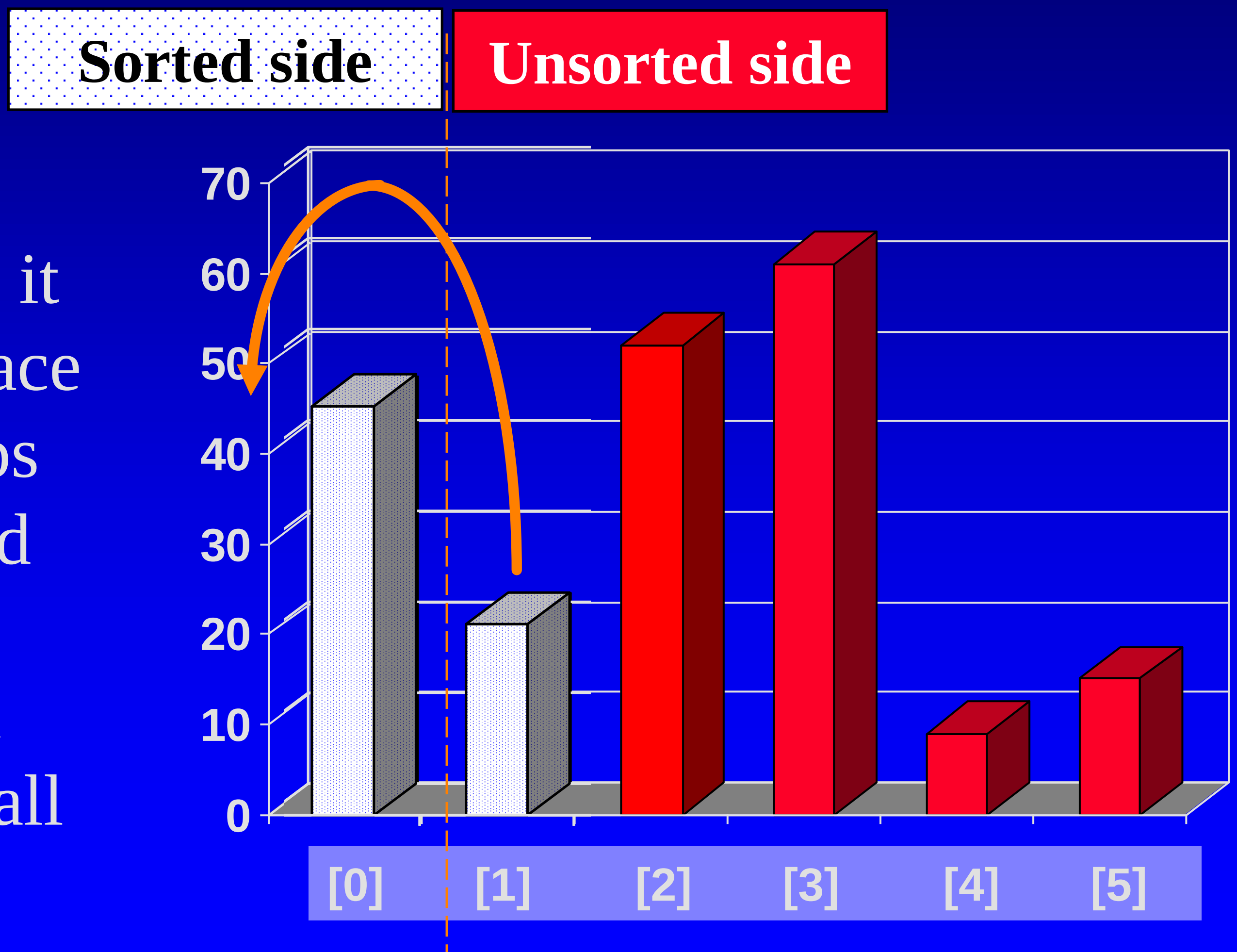
The Insertionsort Algorithm

- The sorted side grows by taking the front element from the unsorted side...



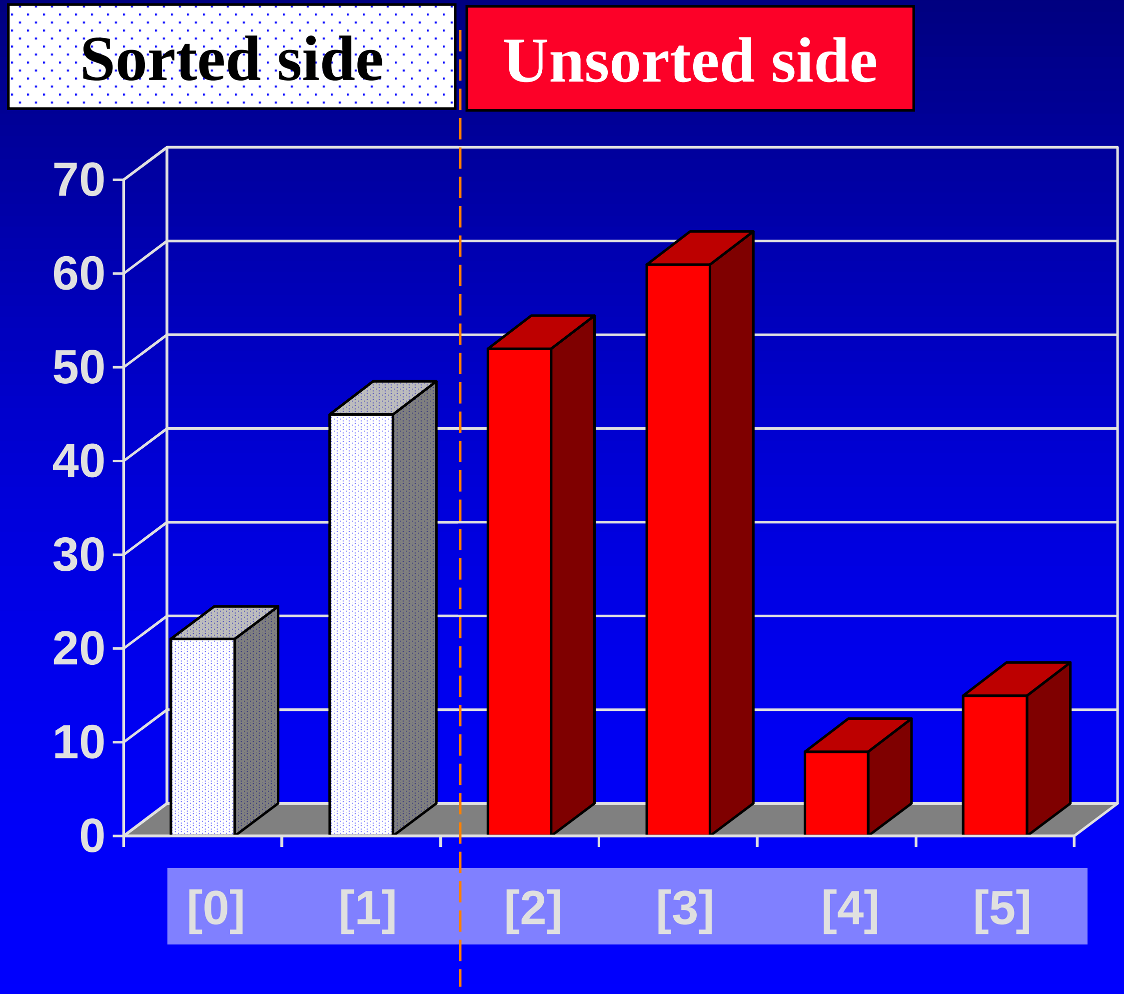
The Insertionsort Algorithm

- ...and inserting it in the place that keeps the sorted side arranged from small to large.



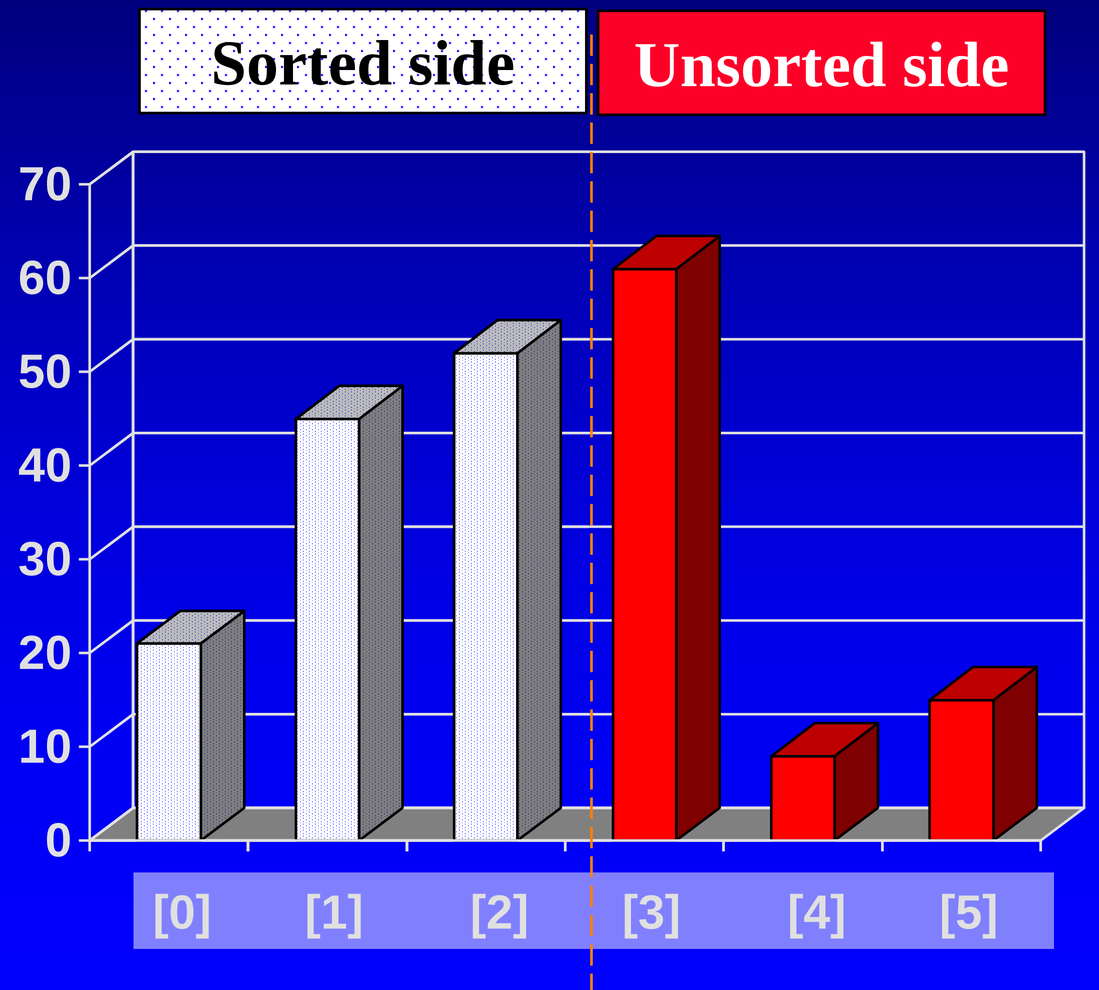
The Insertionsort Algorithm

- In this example, the new element goes in front of the element that was already in the sorted side.



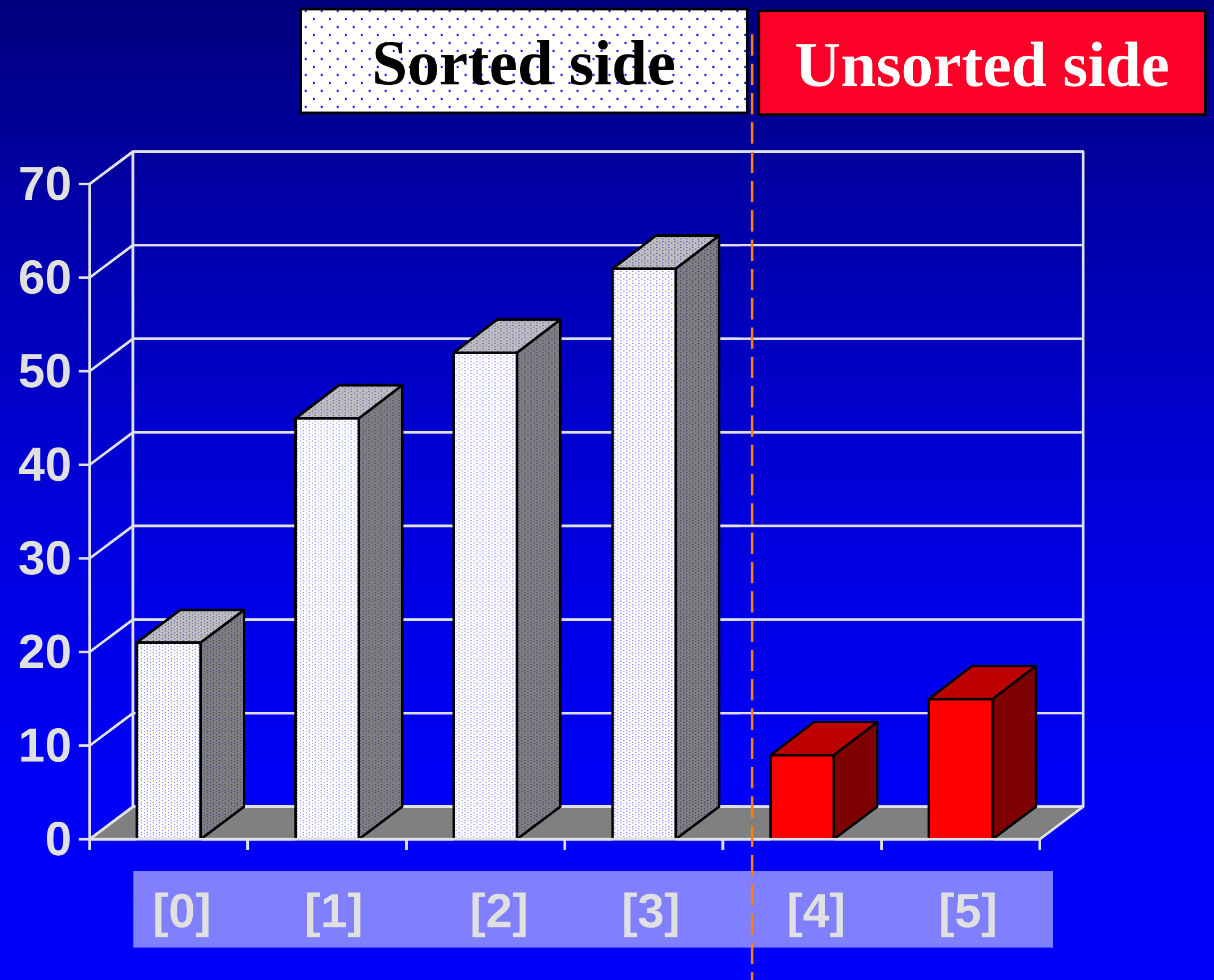
The Insertionsort Algorithm

- Sometimes we are lucky and the new inserted item doesn't need to move at all.



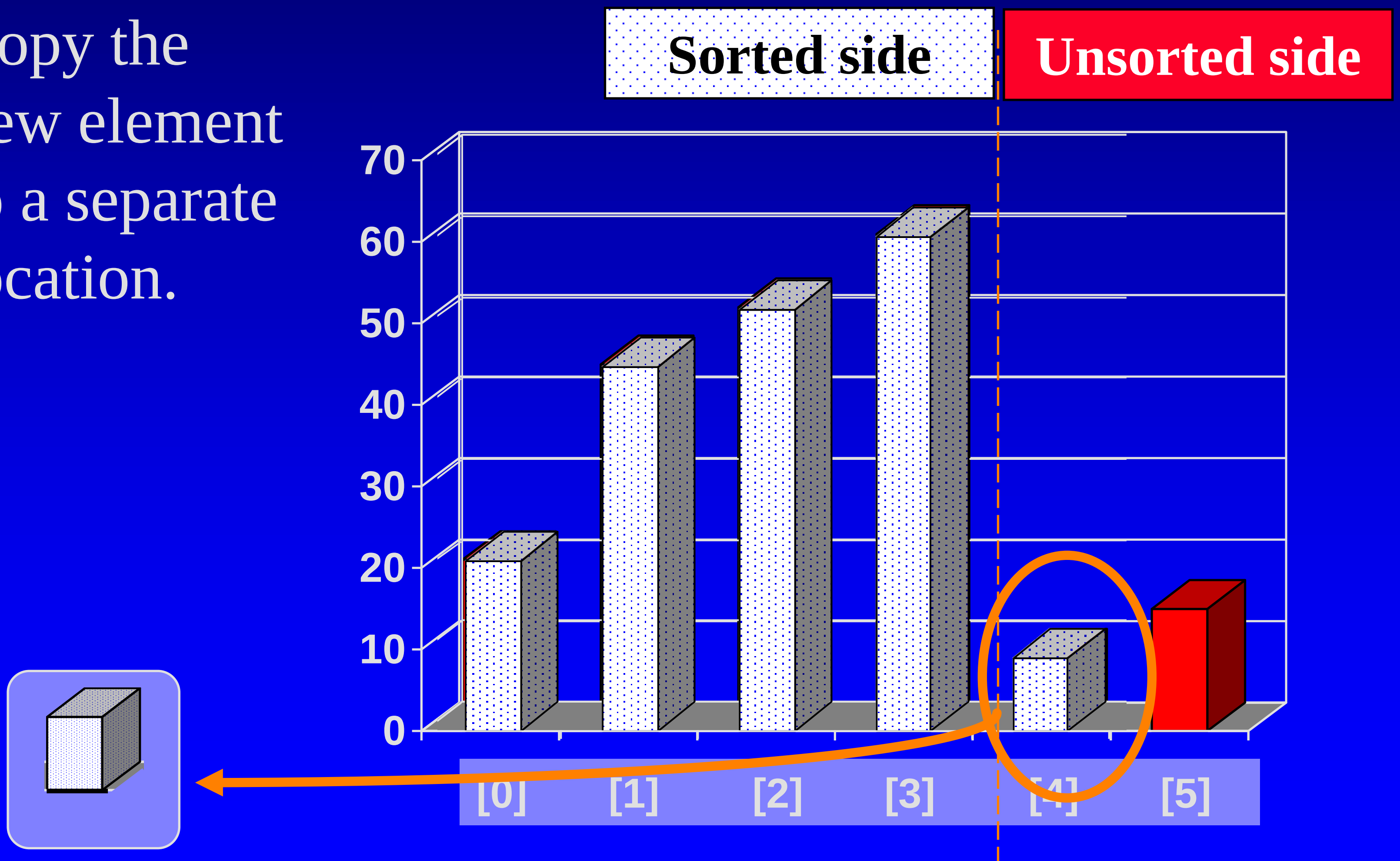
The Insertionsort Algorithm

- Sometimes we are lucky twice in a row.



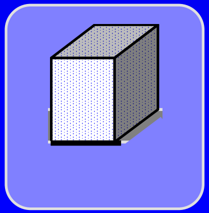
How to Insert One Element

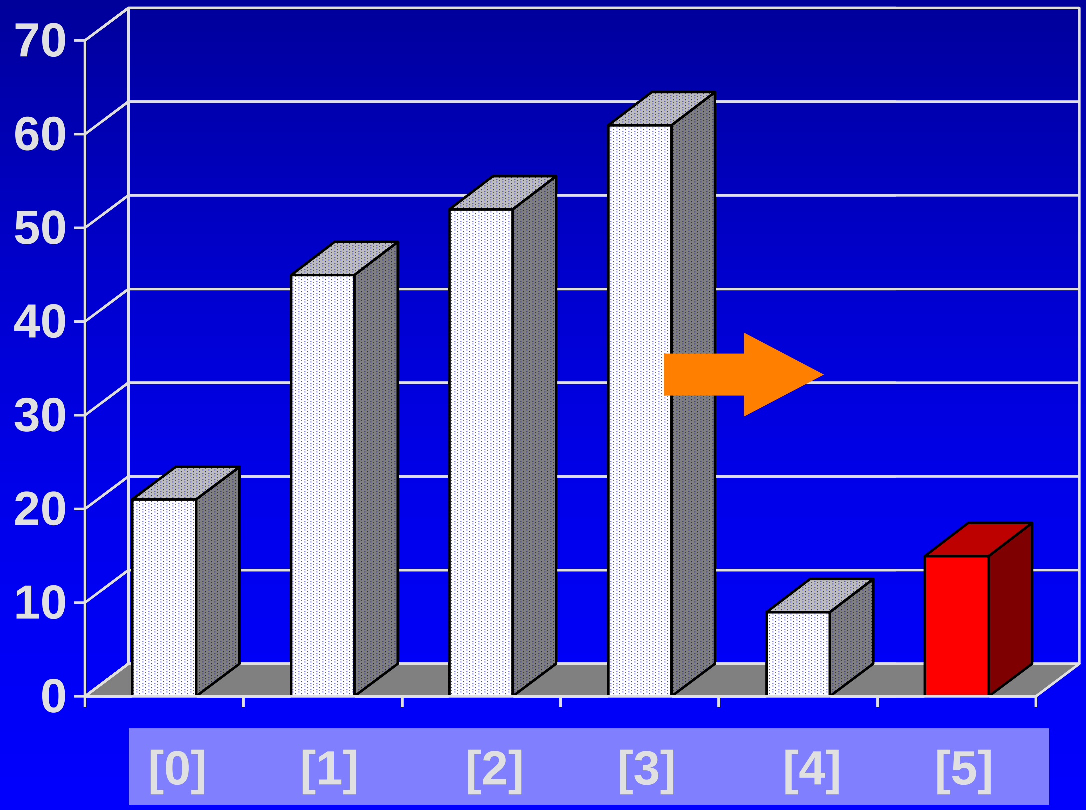
- Copy the new element to a separate location.



How to Insert One Element

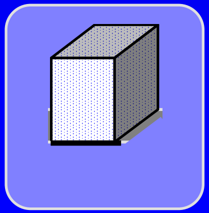
- Shift elements in the sorted side, creating an open space for the new element.

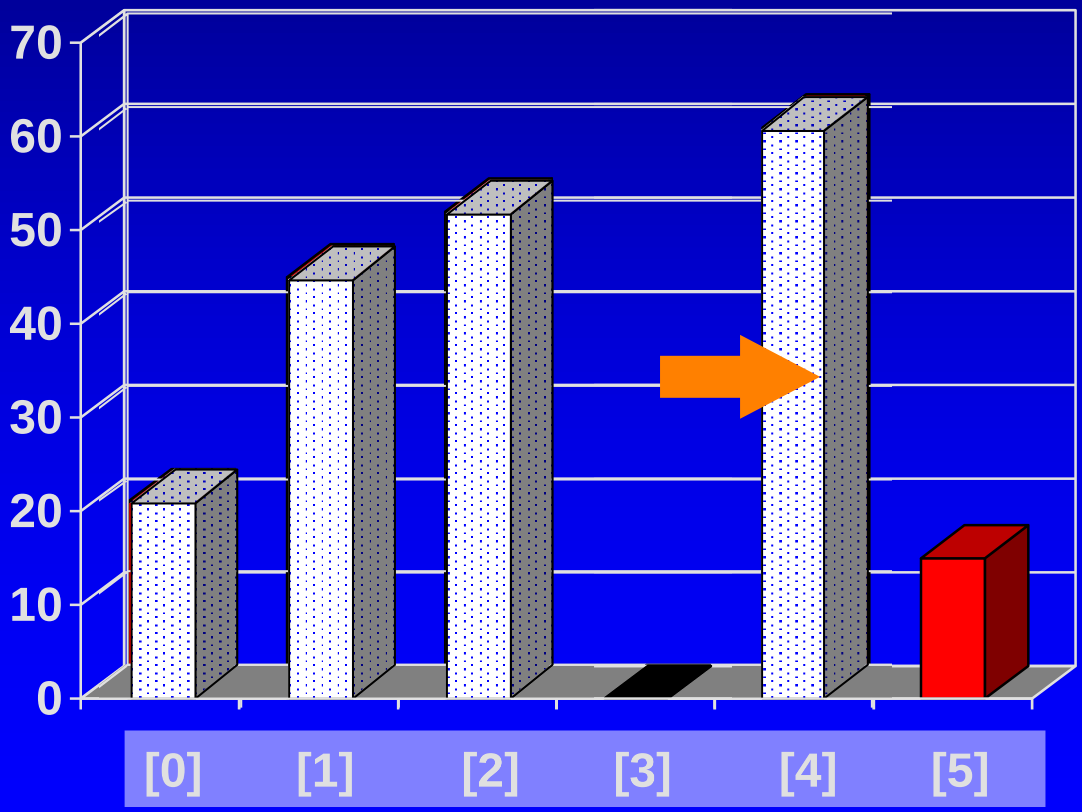




How to Insert One Element

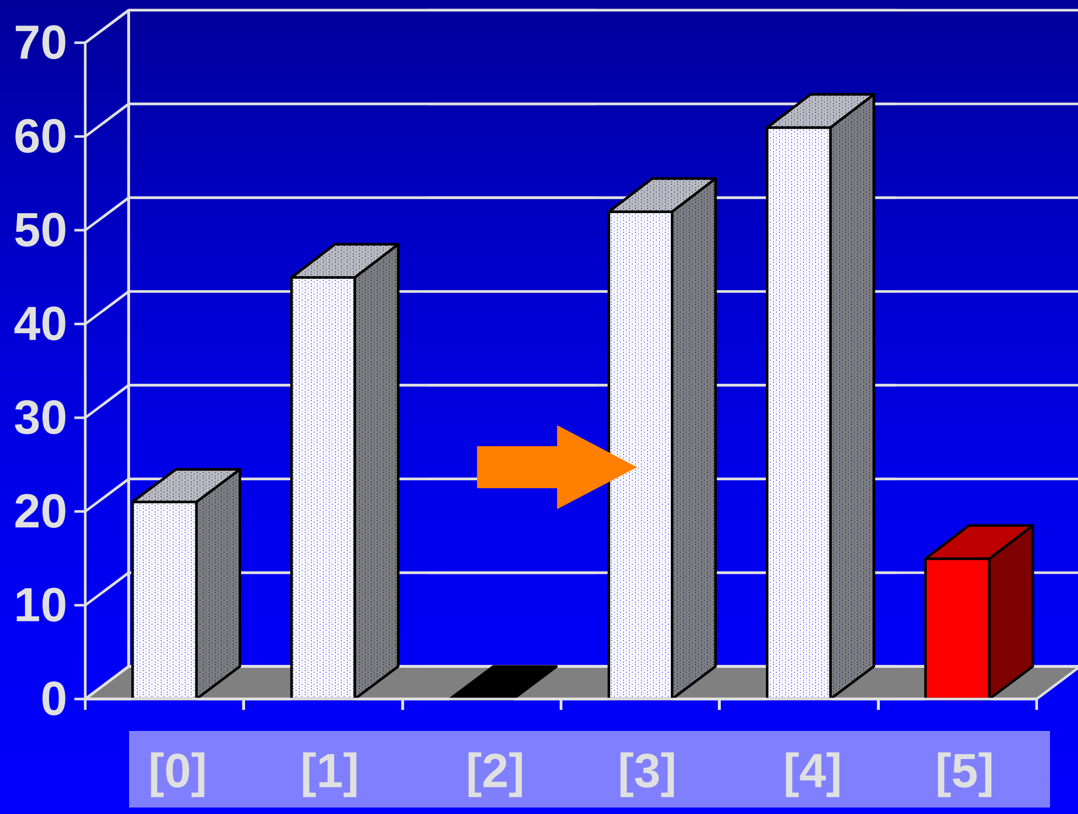
- Shift elements in the sorted side, creating an open space for the new element.

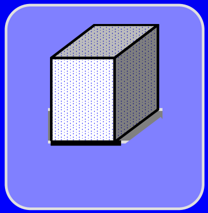




How to Insert One Element

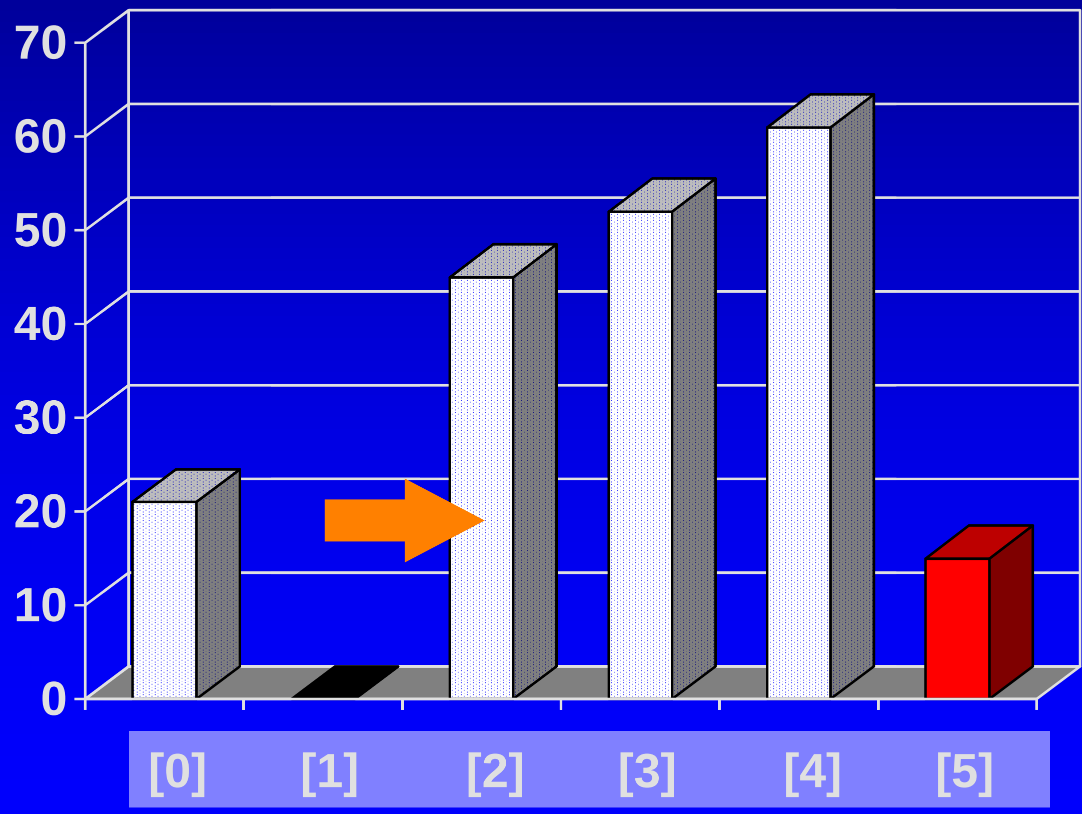
- Continue shifting elements...

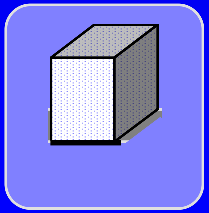




How to Insert One Element

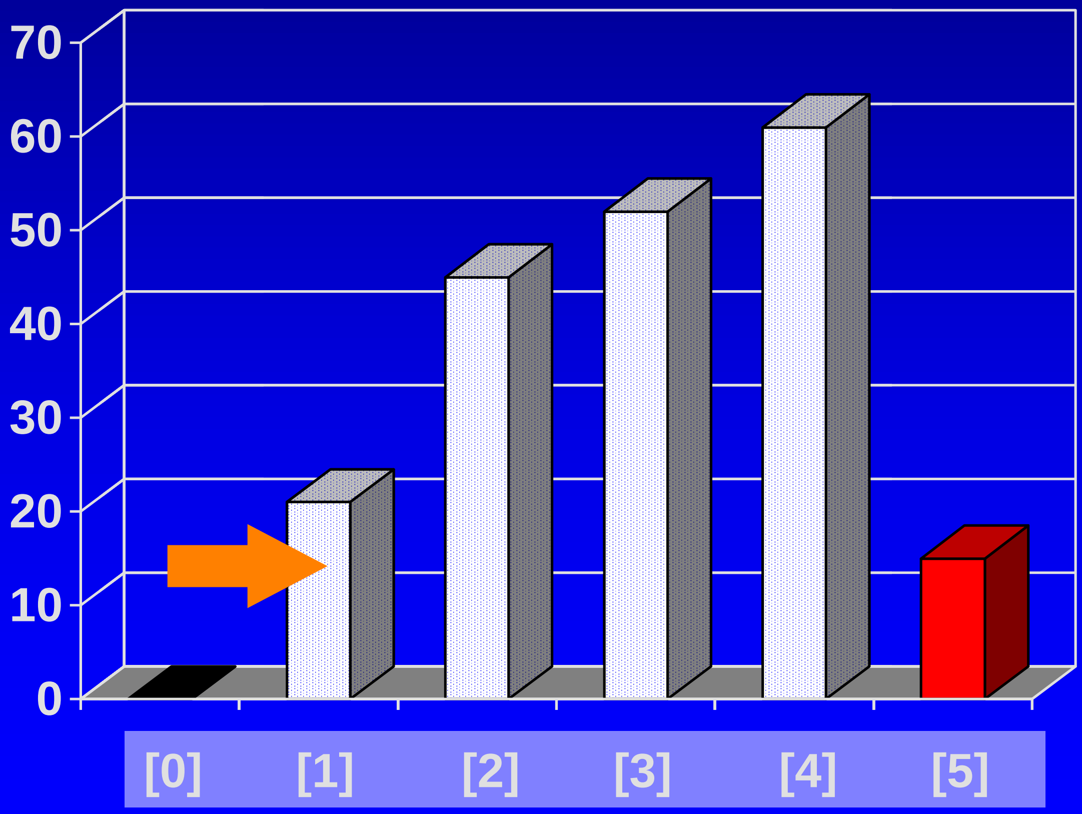
- Continue shifting elements...

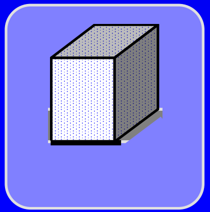




How to Insert One Element

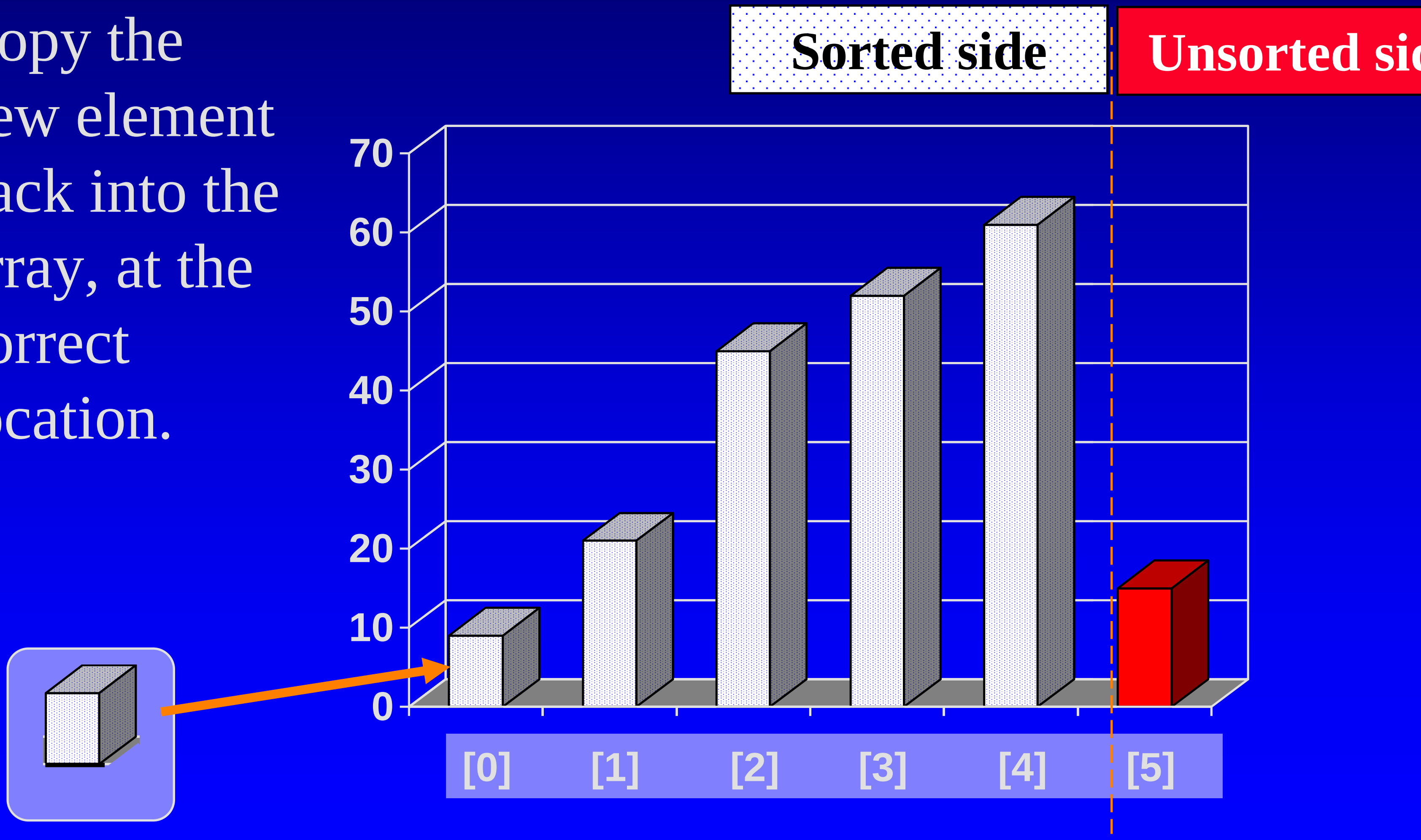
- ...until you reach the location for the new element.





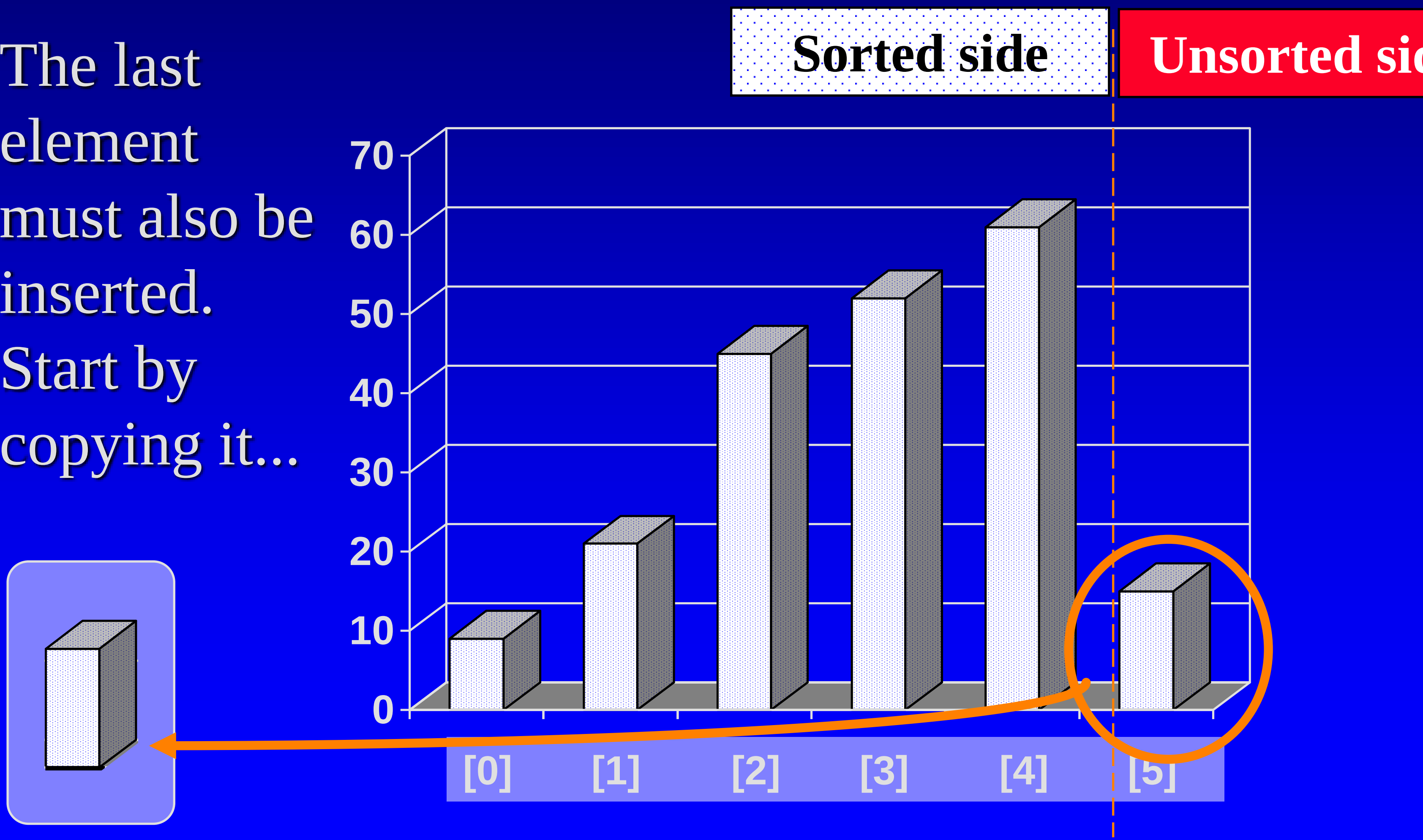
How to Insert One Element

- Copy the new element back into the array, at the correct location.



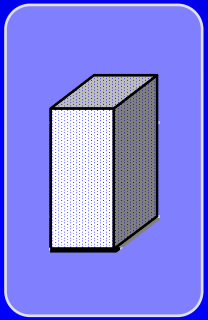
How to Insert One Element

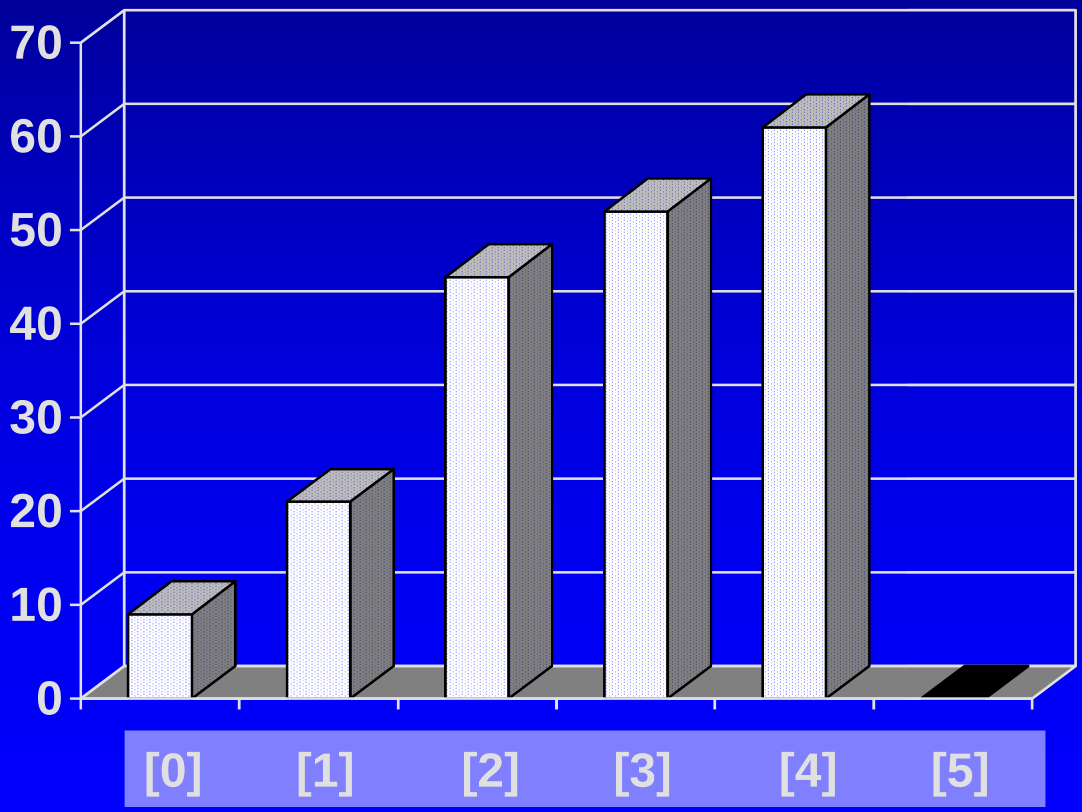
- The last element must also be inserted. Start by copying it...



A Quiz

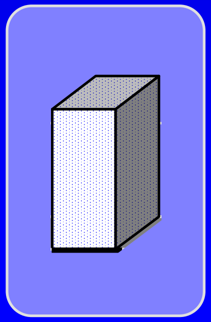
How many shifts will occur before we copy this element back into the array?

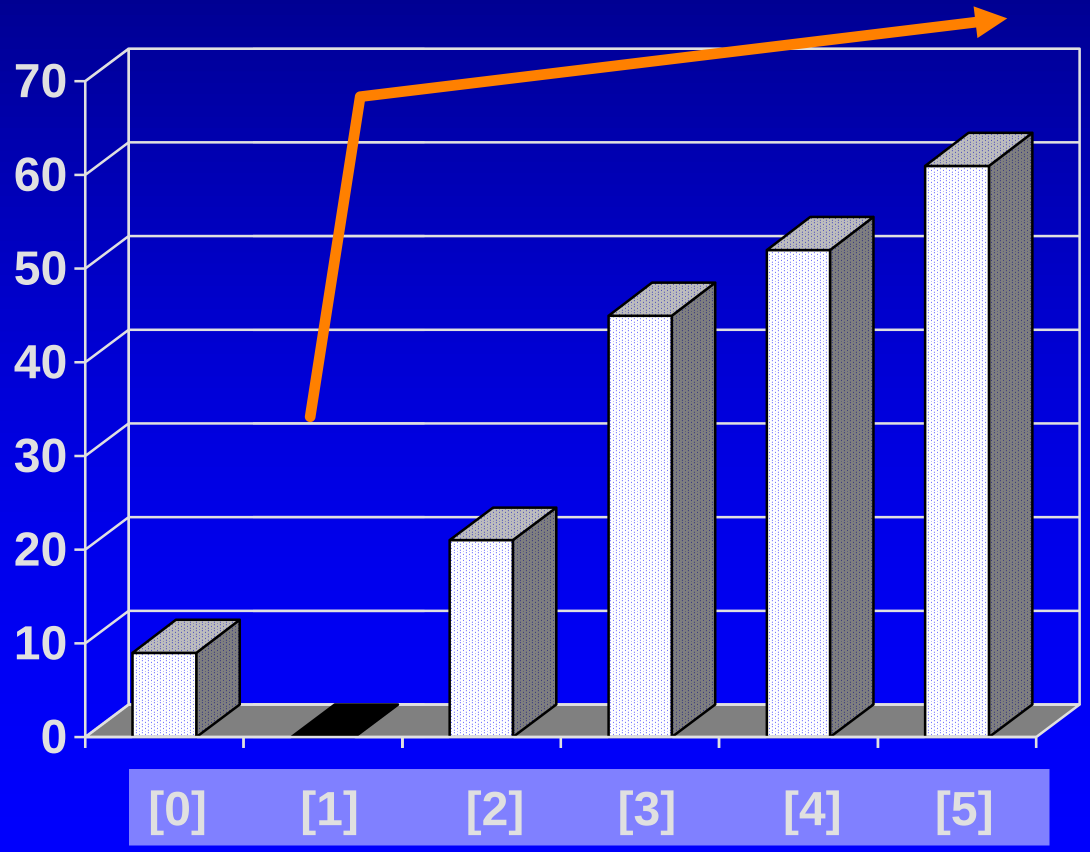




A Quiz

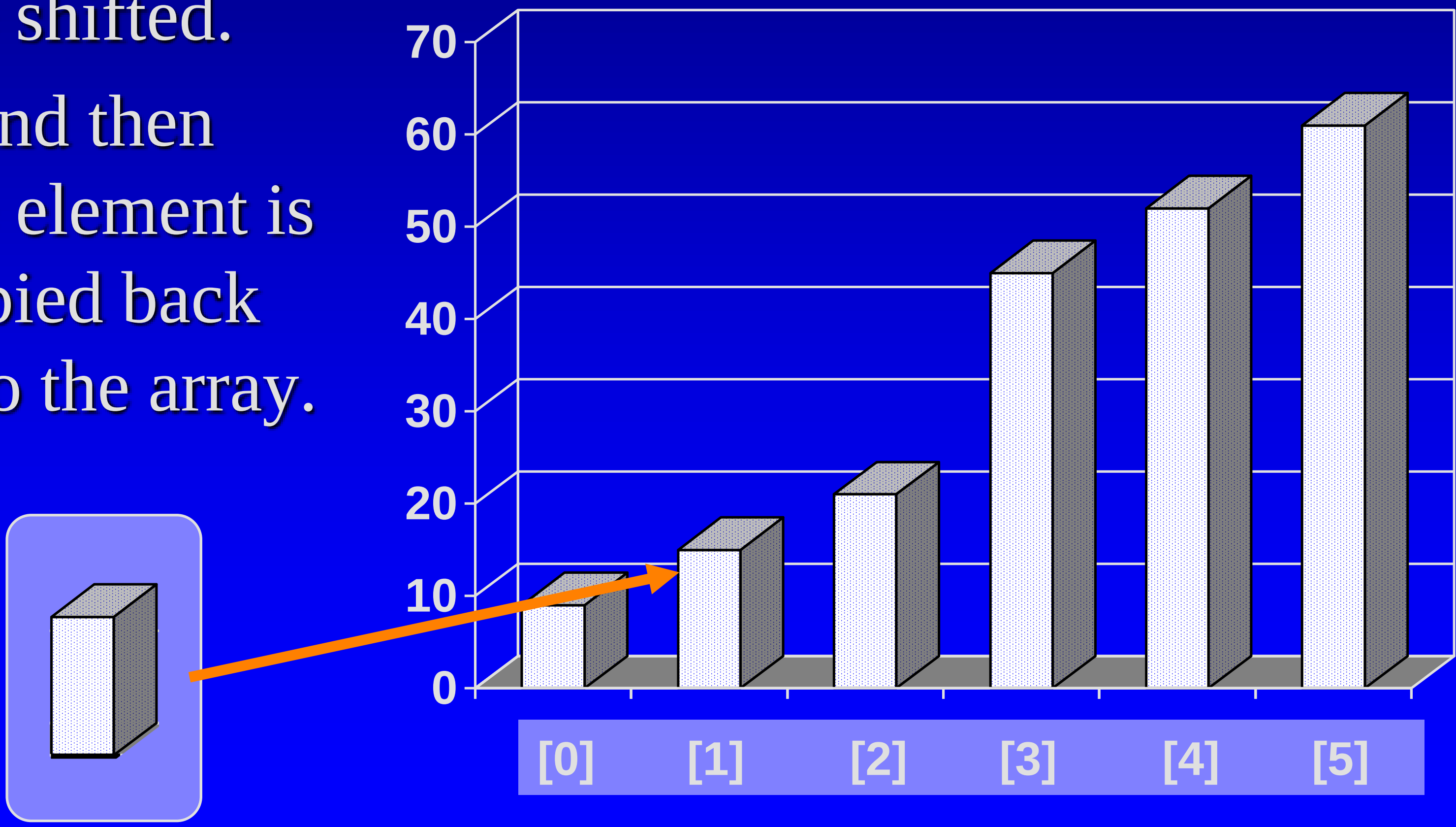
- Four items are shifted.





A Quiz

- Four items are shifted.
- And then the element is copied back into the array.

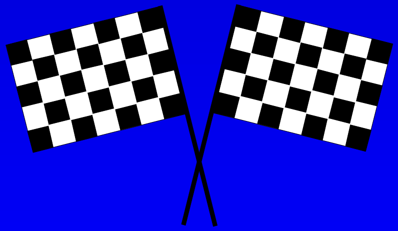


The Insertionsort Algorithm

- Question 1:
  - Can you write out the code easily?
- Question 2:
  - What is the Big-O of the insertsort algorithm?
- Question 3:
  - Best case, worst case and average case
  - deterministic?

Timing and Other Issues

- Both Selectionsort and Insertionsort have a worst-case time of $O(n^2)$, making them impractical for large arrays.
- But they are easy to program, easy to debug.
- Insertionsort also has good performance when the array is nearly sorted to begin with.
- But more sophisticated sorting algorithms are needed when good performance is needed in all cases for large arrays.



THE END