

# A study on bubble short

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## Abstract

This paper presents a comprehensive study of the Bubble Sort algorithm. We discuss its historical background, operational methodology, runtime complexity, and typical applications. Additionally, a comparative analysis with other sorting algorithms is provided to highlight its strengths and limitations.

## 1 Introduction

Bubble Sort is a fundamental sorting algorithm that repeatedly steps through a list, compares adjacent elements, and swaps them if they are in the wrong order. First described in early computer science literature, it is often used as an educational tool due to its simplicity. While inefficient for large datasets, Bubble Sort helps illustrate core sorting concepts.

## 2 Methodology

The Bubble Sort algorithm operates by iterating over the list multiple times. During each pass, it compares each pair of adjacent elements and swaps them if they are out of order. This process continues until a complete pass occurs with no swaps, indicating the list is sorted.

## 3 Runtime Analysis

The time complexity of Bubble Sort is:

$$T(n) = O(n^2) \quad (1)$$

due to the nested loops that potentially compare all pairs of elements in the worst case.

The space complexity is:

$$S(n) = O(1) \quad (2)$$

as it requires only a constant amount of extra memory for swapping elements.

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### Algorithm 1 Bubble short

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```
procedure BUBBLESORT(A[1..n])  
  for  $i = 1$  to  $n - 1$  do  
    for  $j = 1$  to  $n - i$  do  
      if  $A[j] > A[j + 1]$  then  
        swap  $A[j]$  and  $A[j + 1]$   
      end if  
    end for  
  end for  
end procedure
```

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Table 1: Comparison of Sorting Algorithms

| Algorithm      | Time Complexity | Space Complexity |
|----------------|-----------------|------------------|
| Bubble Sort    | $O(n^2)$        | $O(1)$           |
| Insertion Sort | $O(n^2)$        | $O(1)$           |
| Merge Sort     | $O(n \log n)$   | $O(n)$           |

## 4 Applications

Bubble Sort is mainly used in educational settings to introduce sorting algorithms. In particular:

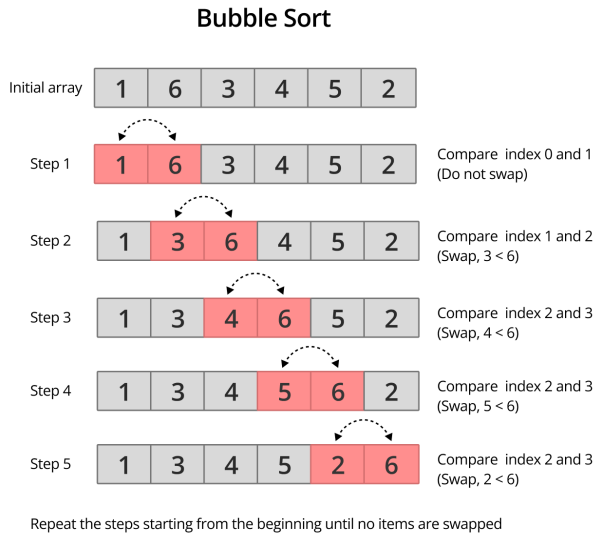


Figure 1: Illustration of the Bubble Sort swapping process

- **Small datasets:** For small or nearly sorted datasets, Bubble Sort can be practical due to its straightforward implementation.
- **Algorithm teaching:** Its intuitive nature makes it an excellent tool for teaching basic algorithm concepts and analysis.

## 5 Conclusion

This paper provided an overview of the Bubble Sort algorithm, describing its methodology, runtime characteristics, and common applications. Despite its inefficiency with large datasets, Bubble Sort remains a valuable educational resource in computer science

## References

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- [2] Overleaf. Overleaf algorithms documentation. <https://www.overleaf.com/learn/latex/Algorithms>. Accessed: 2025-09-08.