



<http://www.internationalhero.co.uk/p/powpuff1.jpg>



<http://www.skorks.com/wp-content/uploads/2010/05/sort.jpg>

# Bubble Sort!

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# What is a bubble sort?!?!?!?!?!?!?!?!?

In a bubble sorting algorithm, the elements of the list "gradually 'bubble' (or rise) to their proper location in the array, like bubbles rising in a glass of soda" (1).



# How does a bubble sort algorithm work?

Bubble sort algorithms cycle through a list, analyzing pairs of elements from left to right, or beginning to end. If the leftmost element in the pair is less than the rightmost element, the pair will remain in that order. If the rightmost element is less than the leftmost element, then the two elements will be switched. This cycle repeats from beginning to end until a pass in which no switch occurs.

# Pointless Image



[http://3.bp.blogspot.com/-\\_XaP-whvEAK/TsQESafndI/AAAAAAAAAGM/IT7WcPCnkJI/s640/running-away.jpg](http://3.bp.blogspot.com/-_XaP-whvEAK/TsQESafndI/AAAAAAAAAGM/IT7WcPCnkJI/s640/running-away.jpg)

# Example A: 5, 12, 3, 9, 16

## Pass 1

- 5, 12, 3, 9, 16
  - The list stays the same because 5 is less than 12.
- 5, 3, 12, 9, 16
  - 3 and 12 are switched because 3 is less than 12
- 5, 3, 9, 12, 16
  - 9 and 12 are switched since 9 is less than 12
- 5, 3, 9, 12, 16
  - 12 and 16 do not switch because 12 is less than 16

# Example A: 5, 12, 3, 9, 16

## Pass 2

- 3, 5, 9, 12, 16
  - 3 is less than 5, so they switch
- 3, 5, 9, 12, 16
  - 5 is less than 9 so they remain in the same places
- 3, 5, 9, 12, 16
  - 12 is greater than 9 so they do not switch places
- 3, 5, 9, 12, 16
  - 12 and 16 are in numerical order so they don't switch

# Example A: 5, 12, 3, 9, 16

## Pass 3

- 3, 5, 9, 12, 16
  - 3 is less than 5, so they do not switch
- 3, 5, 9, 12, 16
  - 5 is less than 9 so they remain in the same places
- 3, 5, 9, 12, 16
  - 12 is greater than 9 so they do not switch places
- 3, 5, 9, 12, 16
  - 12 and 16 are in numerical order so they don't switch

# Another Purposeless Image





# Example B: z, m, g, i, p, a

## Pass 1

m z g i p a  
m g z i p a  
m g i z p a  
m g i p z a  
m g i p a z

## Pass 2

g m i p a z  
g i m p a z  
g i m p a z  
g i m a p z  
g i m a p z

## Pass 3

g i m a p z  
g i m a p z  
g i a m p z  
g i a m p z  
g i a m p z

## Pass 4

g i a m p z  
g a i m p z  
g a i m p z  
g a i m p z  
g a i m p z

## Pass 5

a g i m p z  
a g i m p z  
a g i m p z  
a g i m p z  
a g i m p z

## Pass 5

a g i m p z  
a g i m p z  
a g i m p z  
a g i m p z  
a g i m p z

# Rabbits and Turtles

- In Example B, it took one pass and five switches to get z to the right place. Higher-value elements, or elements that occur at the end of the sequence, take few passes and switches to get to the right spots. These are called "rabbits" (2).
- In example B, it took five passes and ten switches to get a to the right place. Lower-value elements move very slowly to their correct places. These are called "turtles" (2).

# More Pictures

**Glinda the good Kitteh says:**



**Find Ur own way back to Oz**

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# Running Time of the Bubble Sort of Data Set Size $n$

- Best-Case:  $O(n)$ . This is the case of the already-sorted sequence (3).
  - $(n)(1) = n$
- Worst-Case:  $O(n^2)$ . At maximum, there will be  $n$  passes through the data, and each pass will test  $n-1$  pairs (3, 4).
  - $(n)(n-1) = n^2 \dots$
- Average:  $O(n^2)$ . (3,4).

# Optimizing the Algorithm

- One way to make the bubble sort more efficient is to take into account the fact that after the  $i$ th pass, the last  $i$  numbers will be in their correct places (5).
- This reduces the running time by half.
  - $(n)(n/2) = (n^2)/2$
- However, many argue that while this optimizes the running time for a worst-case scenario, this renders the term "bubble sort" invalid for this type of algorithm (6).

# Picture



**Tiny bubbles...**

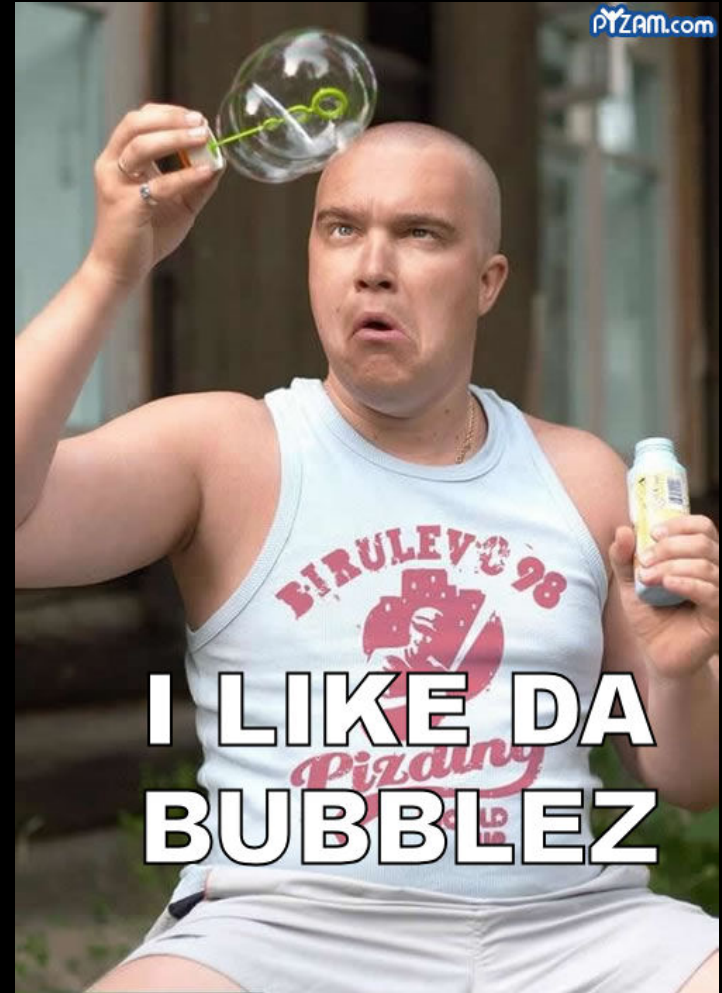
**in the wind**

**make me feel happy...**

IHASAHOTDOG.COM BY 🍌 ☹ 🍌

# Lowering Efficiency

There are not many ways that one would actually use that would make the algorithm less efficient, mostly because it is not a very efficient algorithm in the first place.



# Memory Efficiency and Data Structures

- The bubble sort is a very memory-efficient because all of the ordering occurs within the array or list itself (7). No new memory is allocated (7).
- No new data structures are necessary, for the same reason.

<http://roknor.com/blog/wp-content/uploads/2011/01/funny-pictures-cat-bites-bubble-wrap.jpg>





# Advantages of the Bubble Sort

- The bubble sort requires very little memory other than that which the array or list itself occupies.
- The bubble sort is comprised of relatively few lines of code.
- With a best-case running time of  $O(n)$ , the bubble sort is good for testing whether or not a list is sorted or not. Other sorting methods often cycle through their whole sorting sequence, which often have running-times of  $O(n^2)$  or  $O(n \log n)$  for this task.
- The same applies for data sets that have only a few items that need to be swapped a few times.

# Disadvantages of the Bubble Sort

- The main disadvantage of the bubble sort method is the time it requires. With a running time of  $O(n^2)$ , it is highly inefficient for large data sets.
- Additionally, the presence of turtles can severely slow the sort.



[http://cdn.10dailythings.com/images/imagestoo\\_20many\\_20bubbles.jpg](http://cdn.10dailythings.com/images/imagestoo_20many_20bubbles.jpg)



**EVEN YOUR COFFEE**

is suprised you woke up this early

**Office Hell**  
officehell.co.uk

<http://www.officehell.co.uk/uploads/items/images/Surprised-Coffee-749.jpg>

# References

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