# Sorting

## Sorting

- A fundamental problem in computing
  - putting a collection of items in order
- Often used as part of another algorithm
  - eg. sort then do many binary searches
  - eg. looking for identical items in array:
    - unsorted: do $O(n^2)$ comparisons
    - sort (O(??)) then scan array and do $O(n)$ comparisons
- There is a `sort()` function in `java.util.Arrays`.

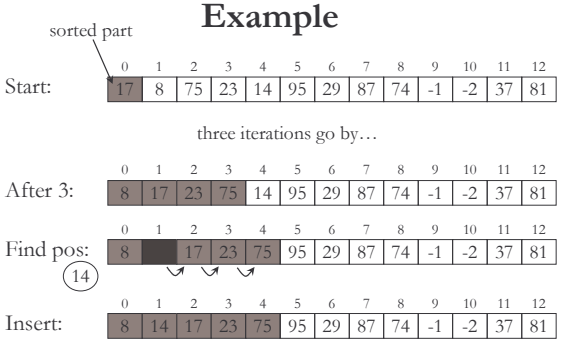
## Sorting Algorithms

- There are many algorithms for sorting.
- Each has different properties:
  - easy/hard to understand
  - fast/slow for large lists
  - fast/slow for short lists
  - fast in all cases/on average

## Insertion Sort

- The idea: Build a sorted part of the array by moving left to right.
  - take the next item in the list
  - find where it should go (in the sorted part)
  - open up a space for it
  - put it in its place
  - repeat for each item/position

## Example

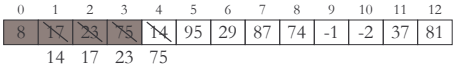



## Pseudocode

```
for pos from 1 to n-1:
    val = array[pos]  // get element pos into place
    i = pos-1
    while i ≥ 0 and array[i] > val:
        array[i+1] = array[i]
        i--
    array[i+1] = val
```

## Example

assume we've done pos = 1, 2, 3…




pos = 4

val = 14

i = ~~3~~ ~~2~~ ~~1~~ 0

## Speed

- requires $n$-1 passes through the array
  - pass $i$ must compare and move up to $i$ elements
  - Total **maximum** comparisons/moves:

    $1 + 2 + \ldots + (n\text{-}1) = n(n\text{-}1)/2 = n^2/2 - n/2$
- So, insertion sort is order n-squared: $O(n^2)$
  - not bad, but there are much faster algorithms
  - turns out: insertion sort is generally faster than other algorithms for small arrays (maybe $n$<10?)

## "Sorting out Sorting"

- 30 min film on sorting algorithms
- Explanation of various sorting algorithms
- Good overview of the ideas the algorithms are based on.
  - Don't worry too much about the details.
  - Tree Sort and Heap Sort require knowledge of tree data structures: don't worry if you don't understand them.