# **Insertion Sort**

Let's start with an example:

### **Example**

#### Pass 1

i 3725

The sorted part of the list is initially empty, so we increment i, and move on to the next item.

#### Pass 2

For this pass, the item at index i is compared with the item at index i - 1. Since 7 is greater than 3, the items are in the correct order and this pass is complete.

#### Pass 3

For this pass, the item at i, which is 2, needs to be inserted into the sorted part of the list.

We know that the value 5 will stay in its current location as we only work with the value at index i and the sorted part of the list.

Since the 2 is less than 7, we move the 7 over one position to the right.

Since the 2 is less than 3, we move the 3 over one position to the right.

```
||i
2 3 7 5
sorted || unsorted
```

Now, the 2 is inserted at index 0.

#### Pass 4

```
||i
2 3 7 5
sorted || unsorted
```

For this pass, the item at i, which is 5, needs to be inserted into the sorted part of the list.

```
|i
2 3 7
sorted || unsorted
```

Since the 5 is less than 7, we move the 7 over one position to the right.

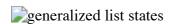
```
∥i
2 3 5 7
sorted ∥ unsorted
```

Since 5 is greater than 3, the 5 is inserted after the 3.

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Our list is now sorted.

#### **Generalized List States**



## **Implementation**

```
def insert(L, i):
    """ (list, int) -> NoneType

    Precondition: L[:i] is sorted from smallest to largest.

    Move L[i] to where it belongs in L[:i + 1].

    >>> L = [7, 3, 5, 2]
    >>> insert(L, 1)
    >>> L
    [3, 7, 5, 2]

# The value to be inserted into the sorted part of the list.
    value = L[i]

# Find the index, j, where the value belongs.
```

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```
# Make room for the value by shifting.
    while j != 0 and L[j - 1] > value:
        # Shift L[j-1] one position to the right to L[j]. L[j] = L[j-1]
        j = j - 1
    # Put the value where it belongs.
    L[j] = value
def insertion_sort(L):
    """ (list) -> NoneType
    Sort the items of L from smallest to largest.
    >>> L = [7, 3, 5, 2]
    >>> insertion_sort(L)
    >>> L
    [2, 3, 5, 7]
    for i in range(len(L)):
        insert(L, i)
if __name__ == '__main__':
    import doctest
```

doctest.testmod()

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