# Sorting Algorithms Implemented

# Announcements

- Lab 8 due Saturday at midnight
  - Ninja sessions tonight and Friday night

# Today's Plan

- Review quiz 4
- Review Monday's lecture
- Implement a sorting algorithm
- Go over selection sort code
- Go over bubble sort code
- Analysis

# Quiz 4 Review

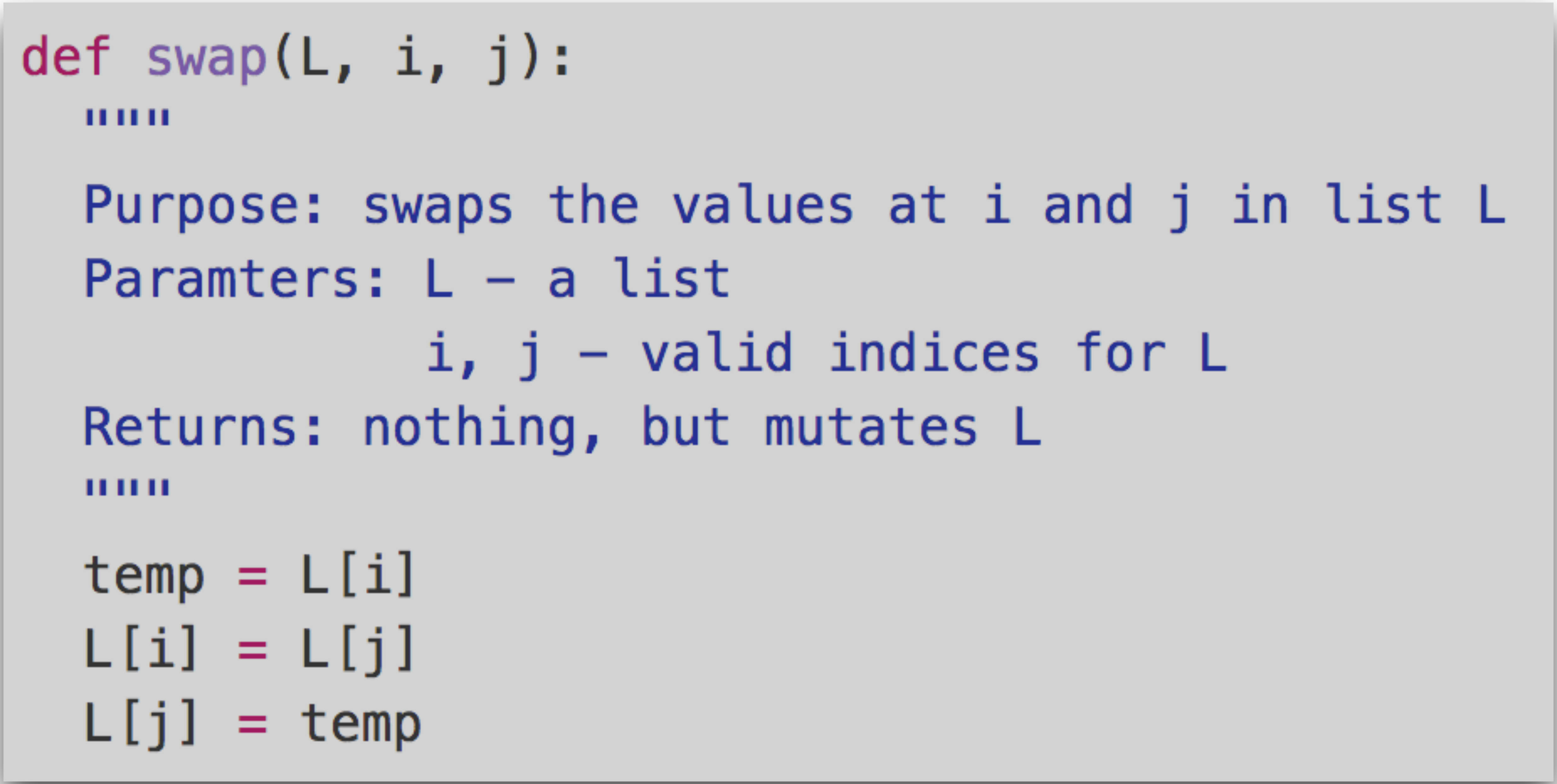
- Q1: Value being mutated only appears once, possibly with multiple arrows pointing to it
- Q2: Need to use `for i in range(len(L))` loop
- Q3: `response = raw_input(question)`
- Q4: `append` method takes one argument, mutates, doesn’t return anything

## Review

- An **in-place sorting algorithm** uses *O(1)* extra space beyond the list being sorted. Such an algorithm can’t create a new list, it must mutate the list passed in.

- These algorithms proceed by orchestrating a series of **swaps** that result in the list being sorted.

# swap function



```python
def swap(L, i, j):
    """
    Purpose: swaps the values at i and j in list L
    Paramters: L - a list
               i, j - valid indices for L
    Returns: nothing, but mutates L
    """
    temp = L[i]
    L[i] = L[j]
    L[j] = temp
```

Implement a sort
in w10-sorting/sorts.py

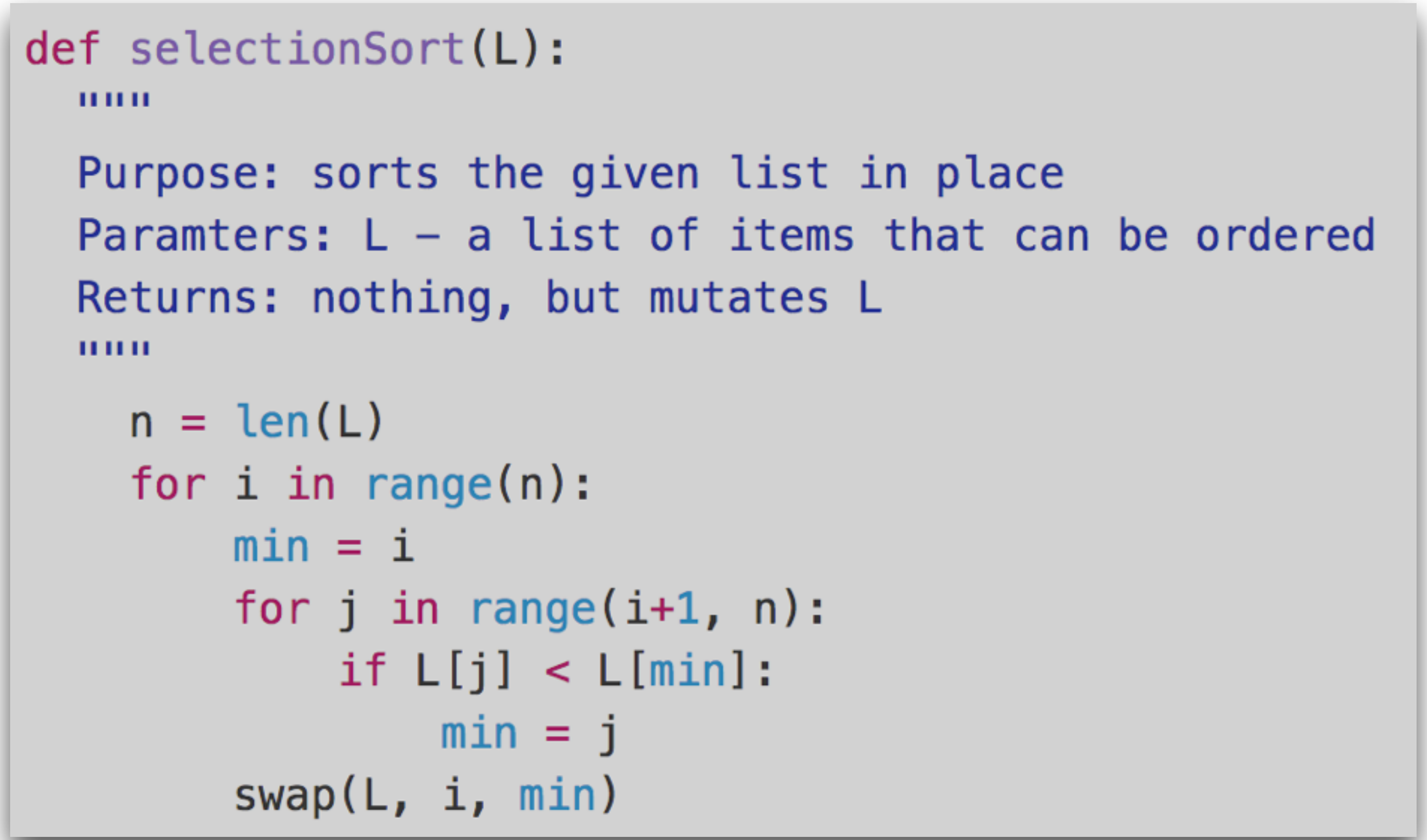
## Selection sort

For each valid position, `i`, in the list:

1. Find the index of the smallest value in the sublist from `i` to the end of the list. Call this index `min`.

2. Swap the values at `i` and `min`.

# Selection sort



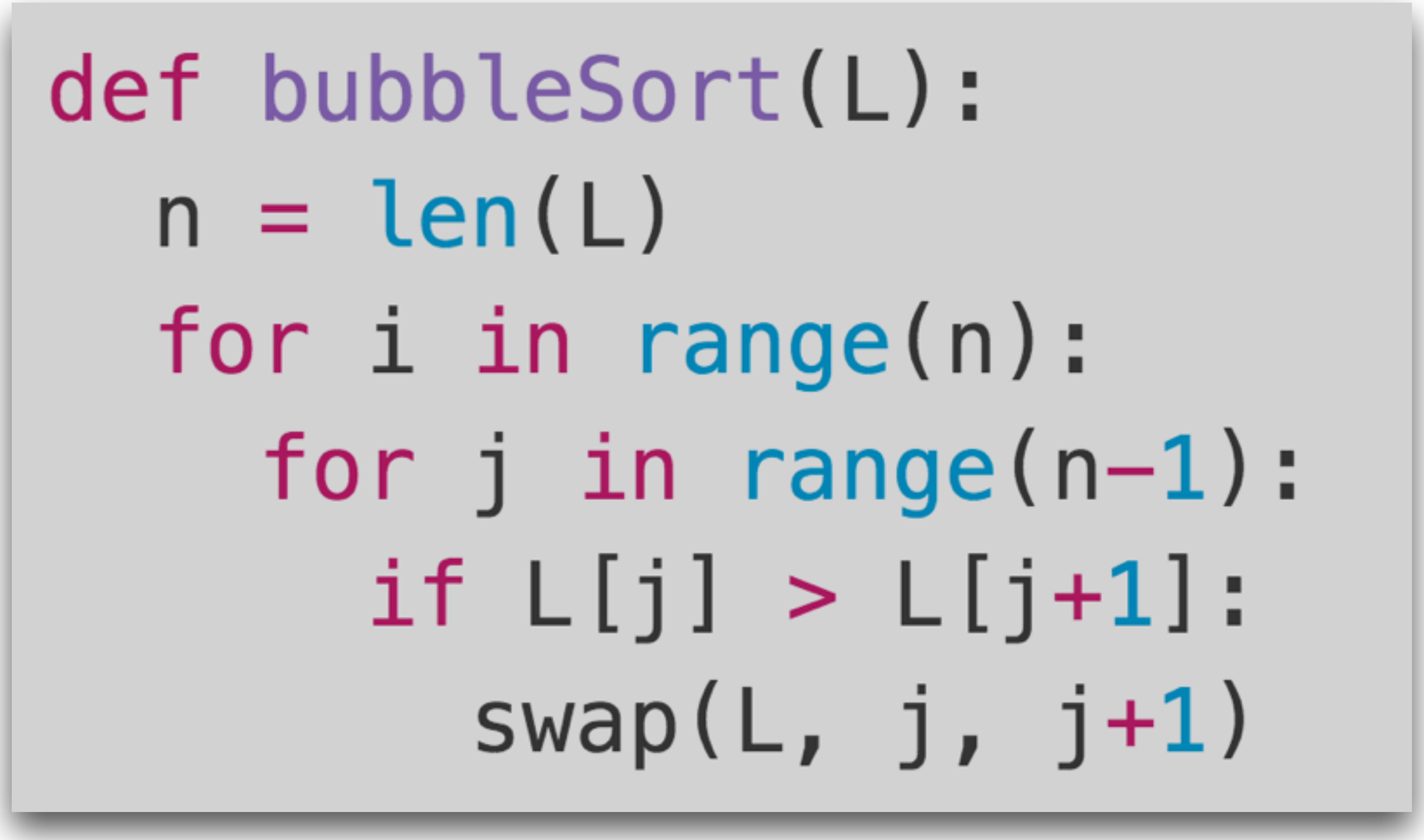
```
def selectionSort(L):
  """
  Purpose: sorts the given list in place
  Paramters: L - a list of items that can be ordered
  Returns: nothing, but mutates L
  """
    n = len(L)
    for i in range(n):
        min = i
        for j in range(i+1, n):
            if L[j] < L[min]:
                min = j
        swap(L, i, min)
```

# Bubble sort

Do the following `n` times to sort a list, `L`, of length `n`:

- Examine each pair of consecutive values in `L`. If the left value is bigger than the right value, swap them.

# Bubble sort



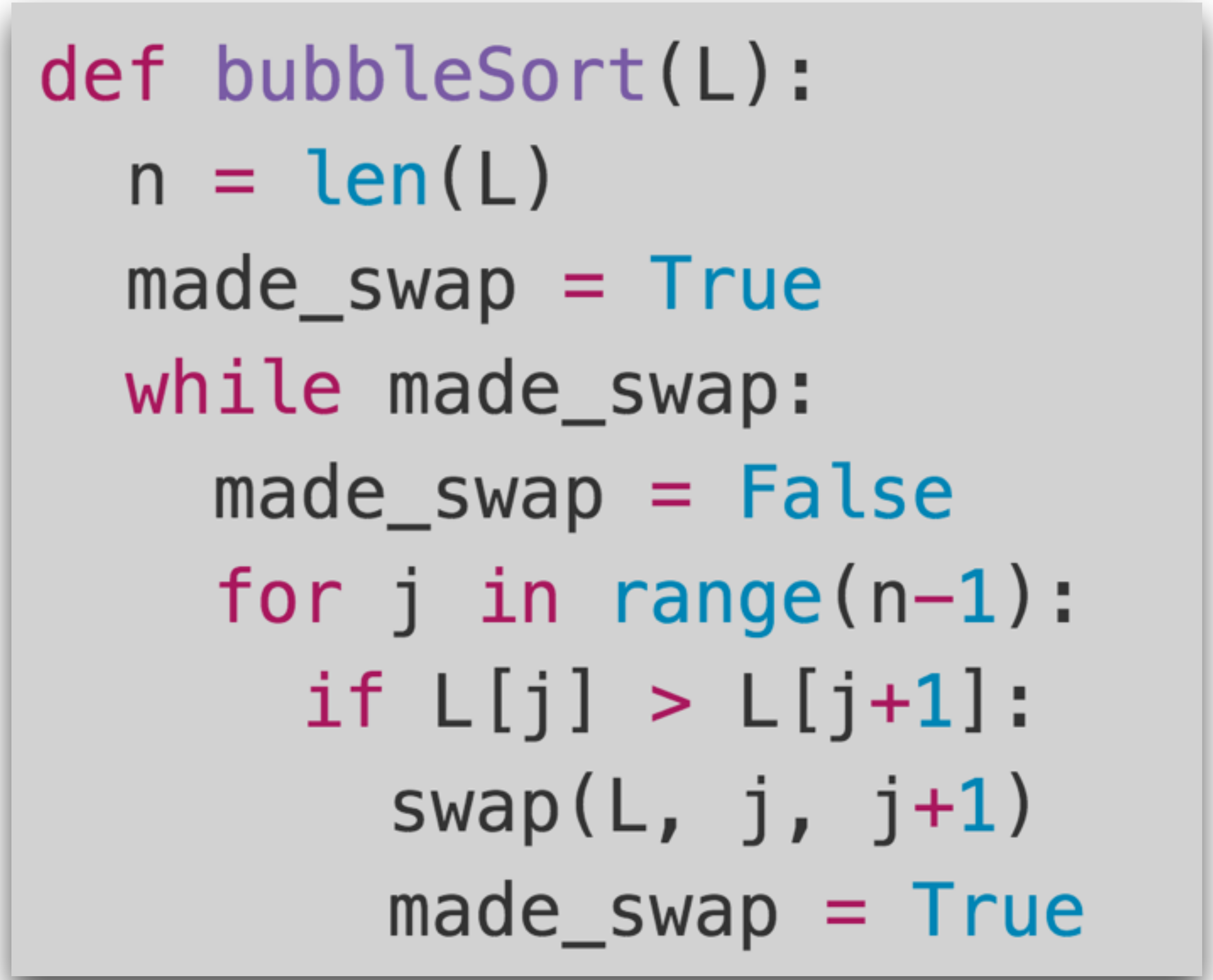
```python
def bubbleSort(L):
  n = len(L)
  for i in range(n):
    for j in range(n-1):
      if L[j] > L[j+1]:
        swap(L, j, j+1)
```

# Bubble sort

Repeat the following until an entire pass of `L` yields no swaps:

- Examine each pair of consecutive values in `L`. If the left value is bigger than the right value, swap them.

# Bubble sort



```python
def bubbleSort(L):
  n = len(L)
  made_swap = True
  while made_swap:
    made_swap = False
    for j in range(n-1):
      if L[j] > L[j+1]:
        swap(L, j, j+1)
        made_swap = True
```

## Analysis

- Selection sort: *$O(n^2)$*
- Bubble sort: *$O(n^2)$*
- We can make minor optimizations, but the big *O* run time won't change.

# Visualizations

- https://visualgo.net/sorting
- https://www.cs.swarthmore.edu/~knerr/teaching/topics/sort.html
- https://www.youtube.com/watch?v=lyZQPjUT5B4#t=0m48s