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How to Implement a Linked List in Python

Exploring how to write Linked List and Node objects from scratch using Python

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Published in Towards Data Science

6 min read · Dec 20, 2021

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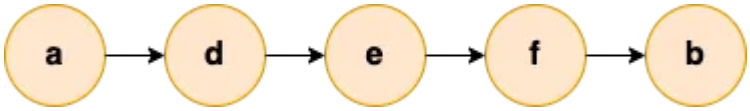
Introduction

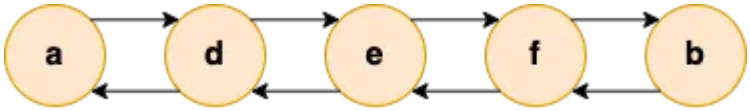
Linked Lists are among the most fundamental data structure that **represents a sequence of nodes**. The first element of the sequence is called the **head** of the Linked List while the last element corresponds to the **tail.**

Every node in the sequence has a pointer to the next element and optionally a pointer to the previous element. In **Singly Linked Lists** each node points to only the next node.



A singly linked list — Source: Author

On the other hand, in **Doubly Linked Lists** each node points to the next as well as to the previous node.



A doubly linked list — Source: Author

Linked Lists are extremely useful in various scenarios. They are typically preferred over standard arrays when

- you need a constant time when adding or removing elements from the sequence
- manage memory more efficiently especially when the number of elements is unknown (if arrays you may have to constantly shrink or grow them. Note though that filled arrays usually take up less memory than Linked Lists.
- you want to insert items in the middle point more efficiently

Unlike other general purpose languages, Python does not have a built-in implementation of Linked Lists in its standard library. In today's article we will explore how to **implement a user-defined Linked List class using Python.**

Implementing User Defined Linked Link Class in Python

First, let's create a user-defined class for individual **nodes** in a Linked List. This class will be suitable for both Singly or Doubly Linked Lists. Therefore, the instances of this class should be capable for storing the value of the node, the next as well as the previous node.

```
class Node:
    def __init__(self, value, next_node=None, prev_node=None):
        self.value = value
        self.next = next_node
        self.prev = prev_node

    def __str__(self):
        return str(self.value)
```

Note that when an instance of a `Node` has `next` set to `None` then it means that it is essentially the tail of the Linked List (either Singly or Doubly). Similarly, in Doubly Linked Lists, when a node has `prev` set to `None` then this indicates that the node is the head of the Linked List.

Now that we have created a class for the Nodes, we can now create the class for the Linked List itself. As mentioned already, a Linked List has a `head`, a `tail` and the nodes pointing to each other.

```
class LinkedList:
    def __init__(self, values=None):
        self.head = None
        self.tail = None

        if values is not None:
            self.add_multiple_nodes(values)
```

Now in order to add the values provided in the constructor as nodes in the Linked List we need to define a couple of additional methods.

The first method called **`add_node`** is used to add a single node to the Linked List.

```
def add_node(self, value):
    if self.head is None:
        self.tail = self.head = Node(value)
    else:
        self.tail.next = Node(value)
        self.tail = self.tail.next
    return self.tail
```

Now let's go through the logic of the method quickly. If the Linked List has no head, then it means it's empty and therefore the node to be added will be both the head and the tail of the Linked List. If the head is not empty, then we add the newly created `Node` as the `next` element of the current `tail` and finally move the tail to point to the newly created `Node`.

The second method is called **`add_multiple_nodes`** which is called in the constructor and in simply calls the `add_node` method we defined earlier in order to add multiple values as nodes in the Linked List instance.

```
def add_multiple_nodes(self, values):
    for value in values:
        self.add_node(value)
```

So far, our Linked List class looks like below:

```
class LinkedList:
    def __init__(self, values=None):
        self.head = None
        self.tail = None

        if values is not None:
            self.add_multiple_nodes(values)

    def add_node(self, value):
        if self.head is None:
            self.tail = self.head = Node(value)
        else:
            self.tail.next = Node(value)
            self.tail = self.tail.next
        return self.tail
```

```
    def add_multiple_nodes(self, values):
        for value in values:
            self.add_node(value)
```

Now let's create an additional method that'd be able to insert a new element but this time in the beginning of the Linked List, i.e. as a head.

```
def add_node_as_head(self, value):
    if self.head is None:
        self.tail = self.head = Node(value)
    else:
        self.head = Node(value, self.head)
    return self.head
```

Now let's override some special methods in our class that could potentially be useful. Firstly, let's implement `__str__` method so that the string representation of a Linked List object is human readable. For example, when printing out a Linked List with nodes `a, b, c, d` the output will be `a -> b -> c -> d`.

```
def __str__(self):
    return ' -> '.join([str(node) for node in self])
```

Secondly, let's also implement `__len__` method that will return the length of our user-defined class, which is essentially the number of nodes included in the sequence. All we need to do is iterate over every node of the sequence until we reach the tail of the Linked List.

```
def __len__(self):
    count = 0
    node = self.head
    while node:
        count += 1
        node = node.next
    return count
```

Finally, let's ensure that `LinkedList` class is iterable by implementing `__iter__` method.

```
def __iter__(self):
    current = self.head
    while current:
        yield current
        current = current.next
```

Additionally, we could also create a property called `values` so that we can access the values of all nodes included in the sequence.

```
@property
def values(self):
    return [node.value for node in self]
```

The final class looks like below:

```
class LinkedList:
    def __init__(self, values=None):
        self.head = None
        self.tail = None

        if values is not None:
            self.add_multiple_nodes(values)

    def __str__(self):
        return ' -> '.join([str(node) for node in self])

    def __len__(self):
        count = 0
        node = self.head
        while node:
            count += 1
            node = node.next
        return count

    def __iter__(self):
        current = self.head
        while current:
            yield current
            current = current.next
```

```
    @property
    def values(self):
        return [node.value for node in self]

    def add_node(self, value):
        if self.head is None:
            self.tail = self.head = Node(value)
        else:
            self.tail.next = Node(value)
            self.tail = self.tail.next
        return self.tail

    def add_multiple_nodes(self, values):
        for value in values:
            self.add_node(value)

    def add_node_as_head(self, value):
        if self.head is None:
            self.tail = self.head = Node(value)
        else:
            self.head = Node(value, self.head)
        return self.head
```

Now even our `Node` class can represent nodes included in either of Singly or Doubly Linked Lists, the `LinkedList` class we defined can only support Singly Linked Lists. This is because when adding nodes, we are not specifying the previous node.

To deal with Doubly Linked Lists, we can simply create an additional class that inherits from `LinkedList` class and overrides the `add_node` and `add_node_as_head` methods:

```
class DoublyLinkedList(LinkedList):
    def add_node(self, value):
        if self.head is None:
            self.tail = self.head = Node(value)
        else:
            self.tail.next = Node(value, None, self.tail)
            self.tail = self.tail.next
        return self

    def add_node_as_head(self, value):
        if self.head is None:
            self.tail = self.head = Node(value)
        else:
            current_head = self.head
            self.head = Node(value, current_head)
```

```
            current_head.prev = self.head
        return self.head
```

Full Code for User-Defined Linked Lists in Python

The full code containing the three classes we created as part of today's tutorial is given below as a GitHub Gist.

The full code containing Node, LinkedList and DoublyLinkedList Python classes — Source: Author

Final Thoughts

In today's guide we discussed about one of the most fundamental data structures, namely Linked Lists. Given that Python's standard library does not contain any implementation of this specific data structure, we explored how one can implement a user-defined Linked List class from scratch.

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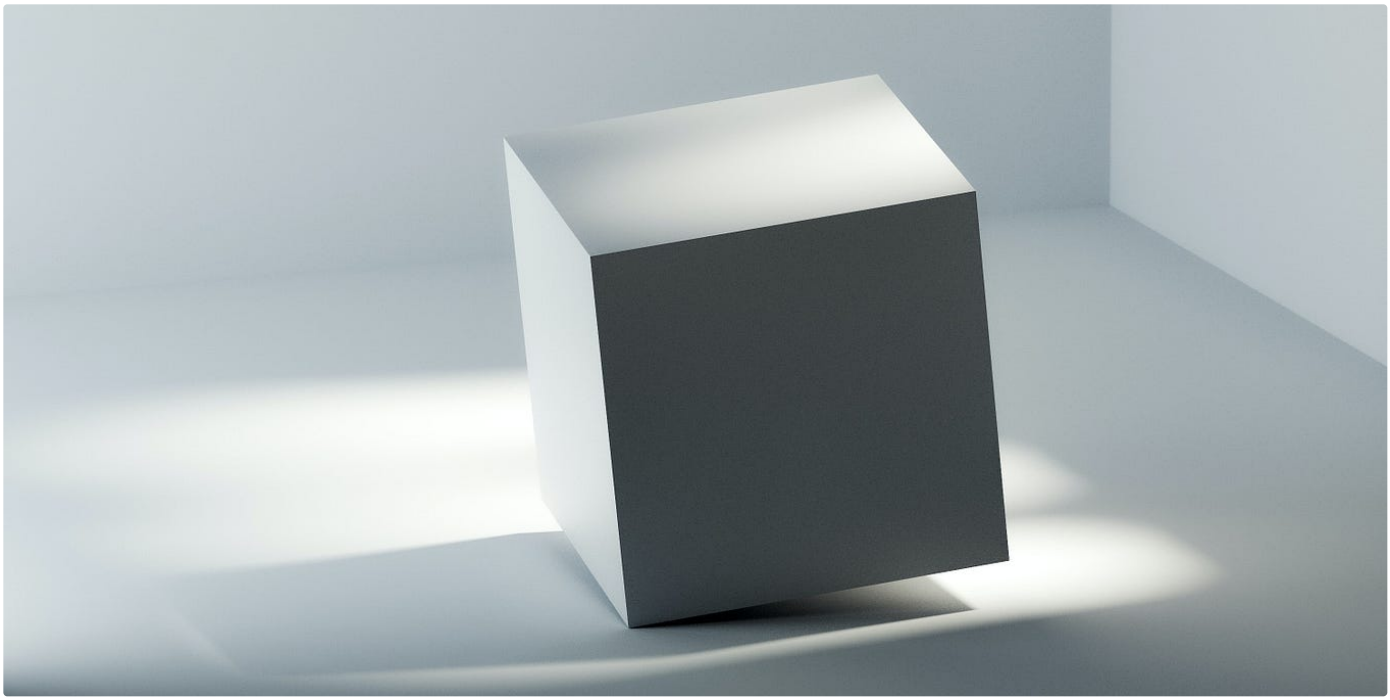

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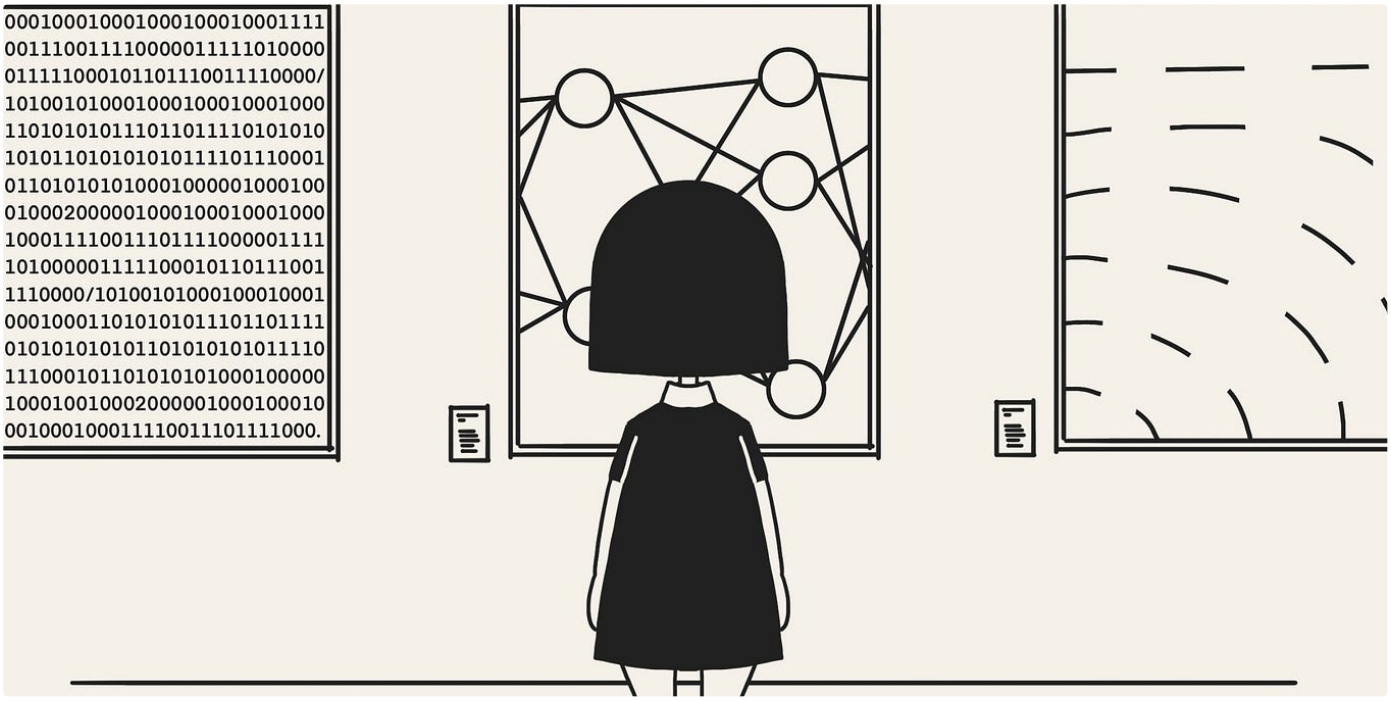

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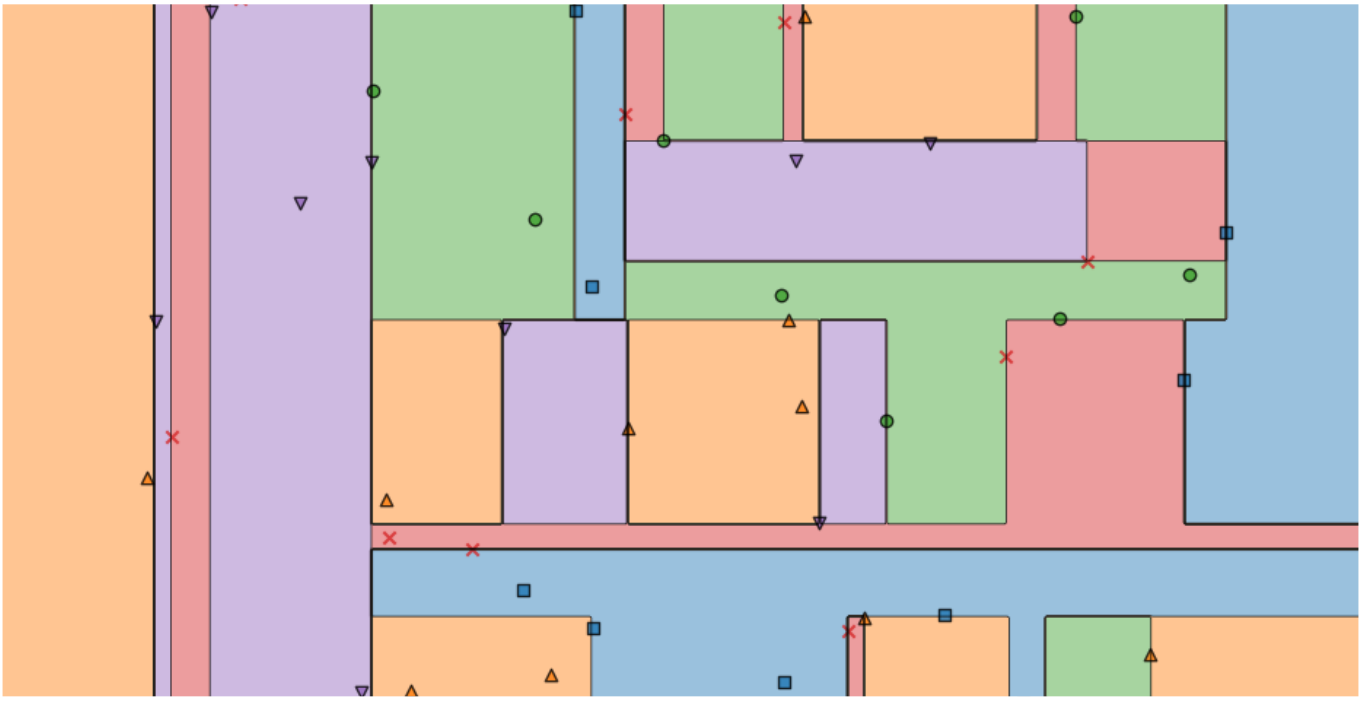

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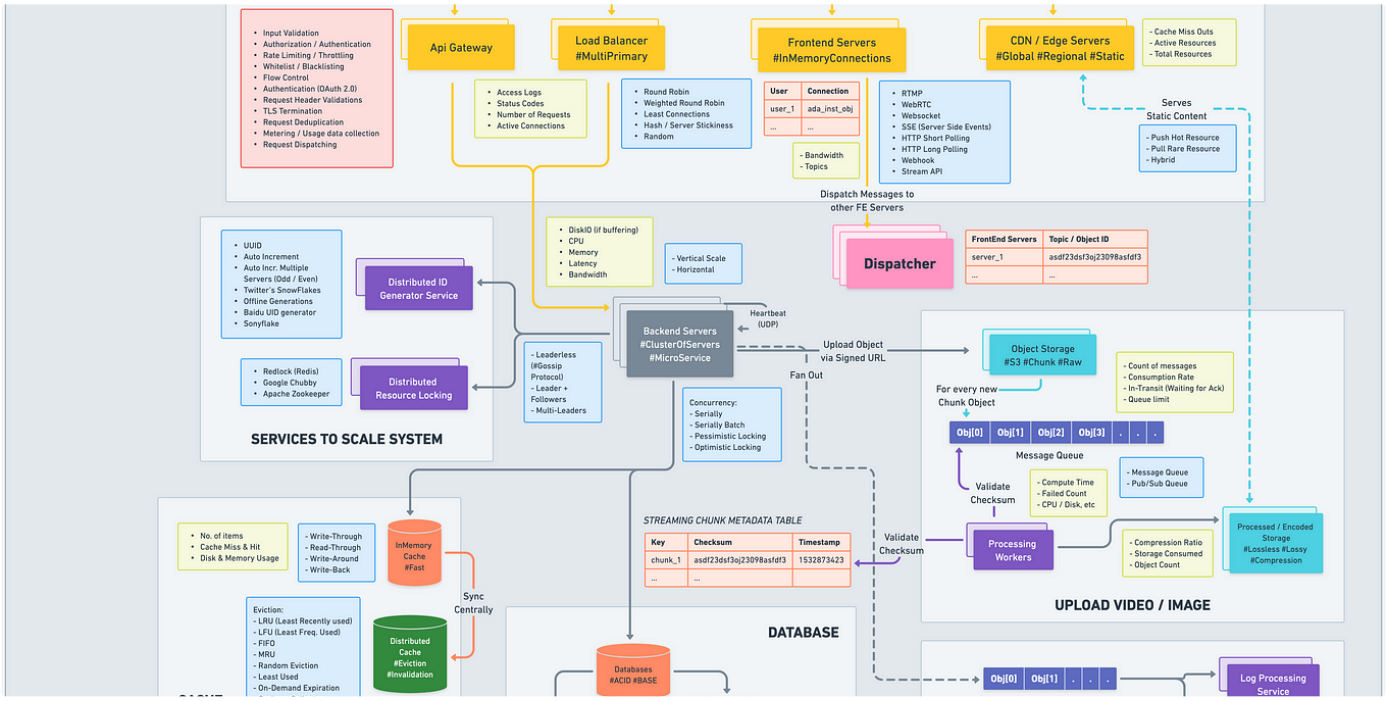

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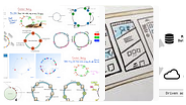

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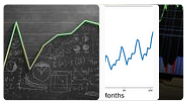

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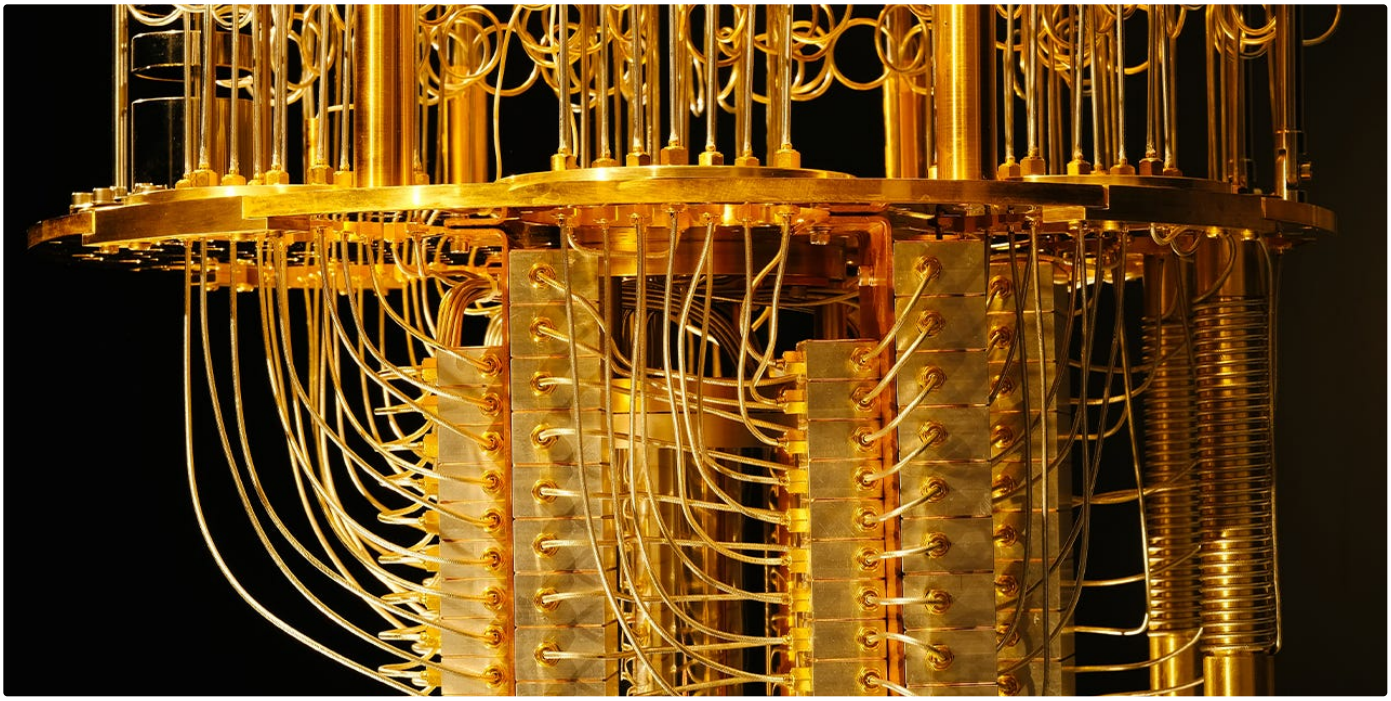

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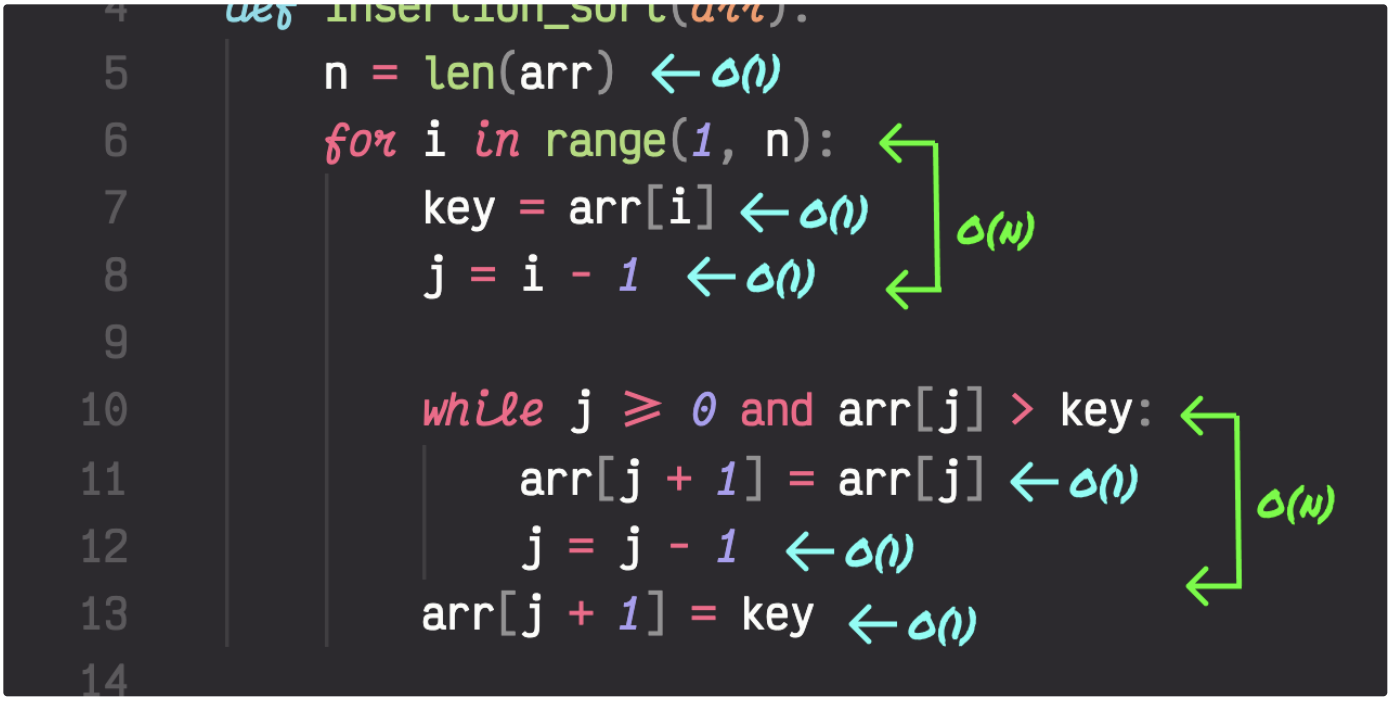

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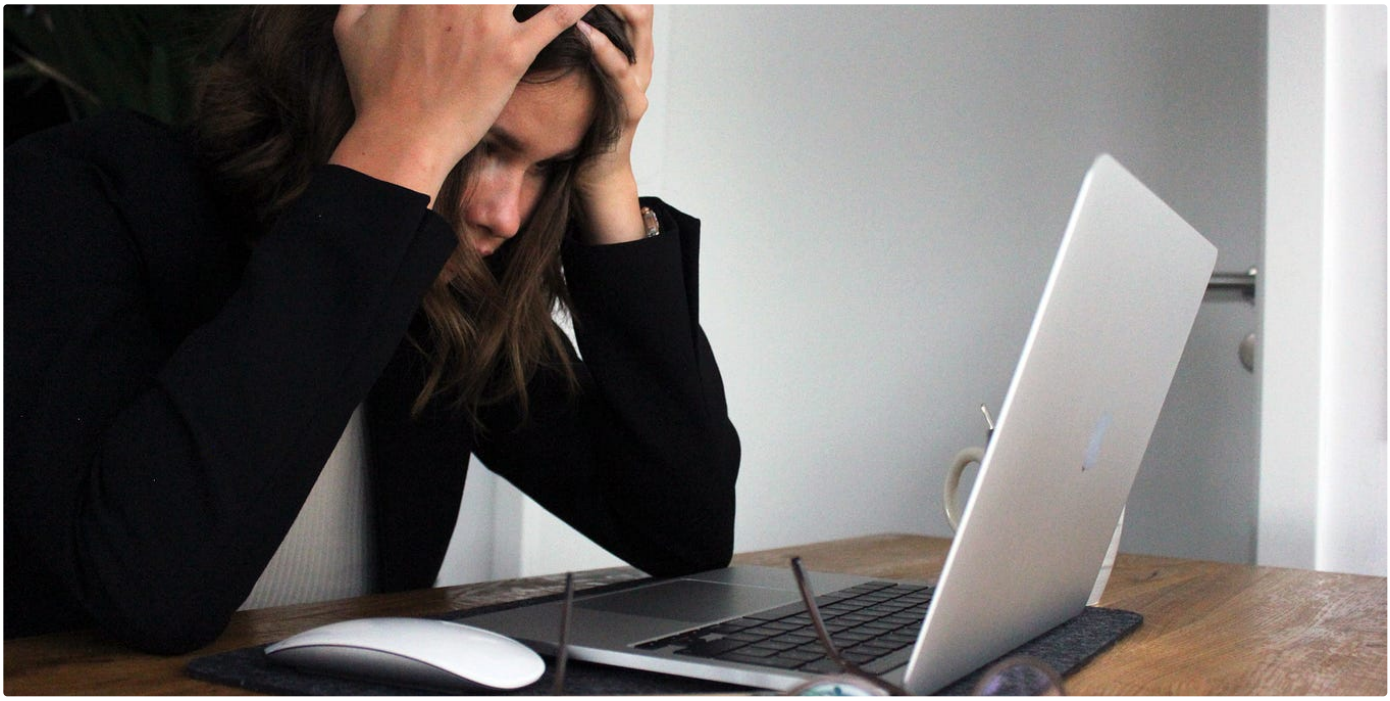

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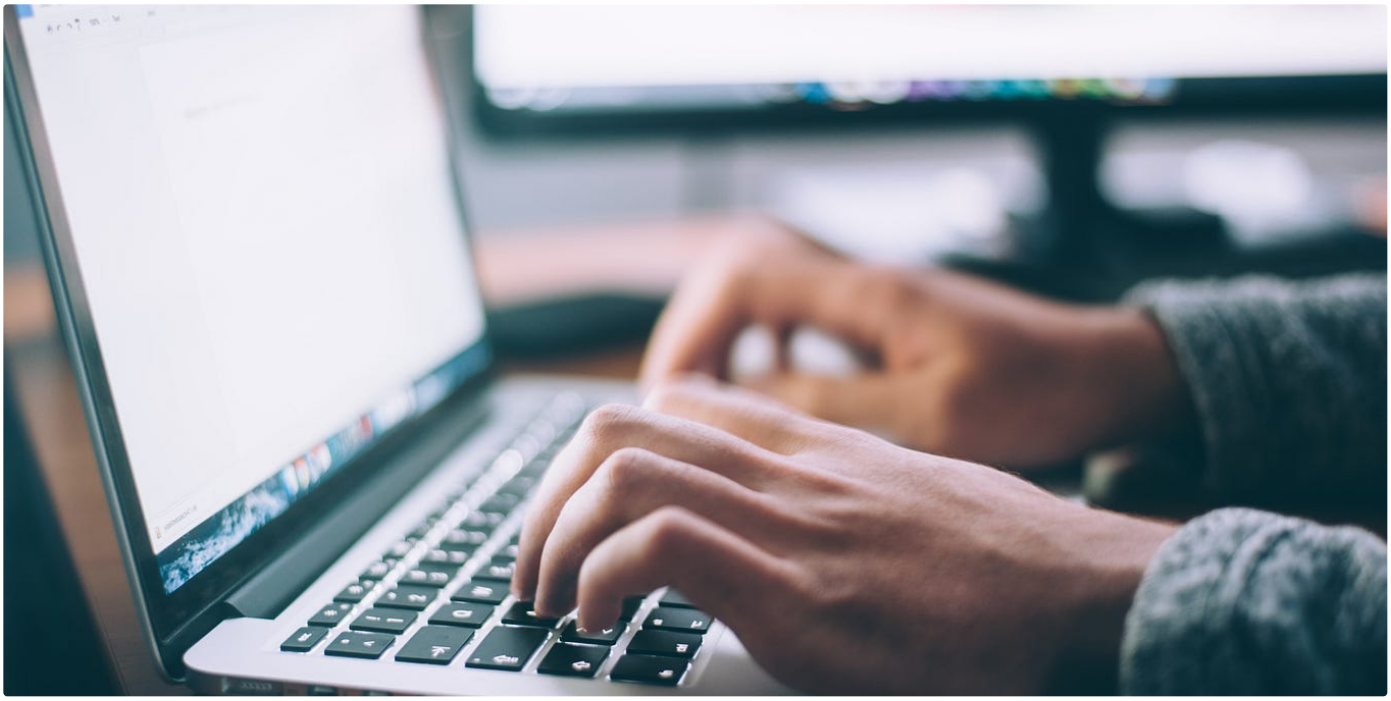

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