CM1602 : Data Structures and Algorithms for AI

3. Array and Linked List

Lecture 3| R. Sivaraman

MODULE CONTENT

Lecture	Topic
Lecture 01	Introduction to Fundamentals of Algorithms
Lecture 02	Analysis of Algorithms
Lecture 03	Array and Linked Lists
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Lecture 07	Trees
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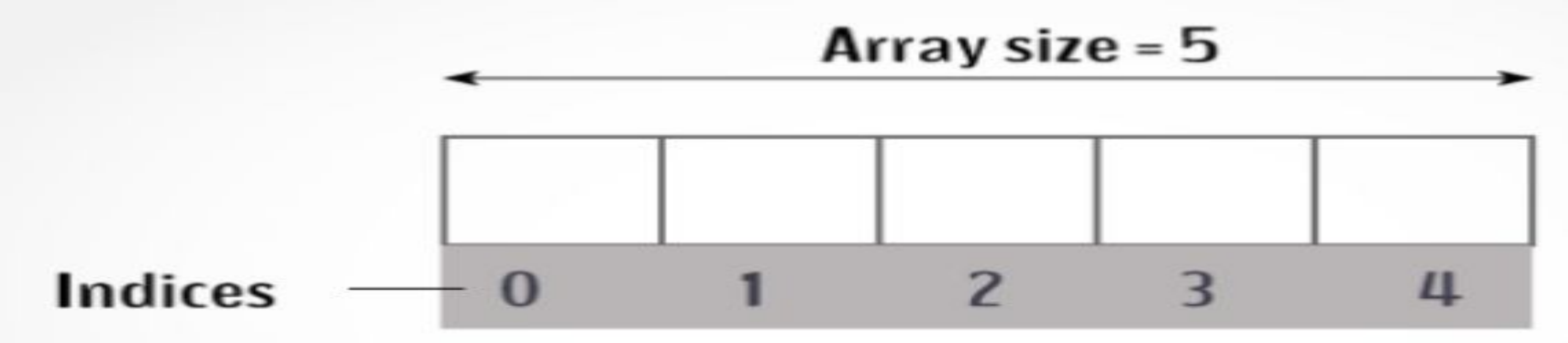
Learning Outcomes

- Covers LO1 : Describe the fundamental concepts of algorithms and data structures.
- Covers LO3 : Apply appropriate data structures given a real-world problem to meet requirements of programming language APIs.
- On completion of this lecture, students are expected to be able to:
  - Describe Array and Linked List
  - Implement an Array
  - Implement a Linked List

Array

Array

- Arrays are used to store multiple values in a single variable

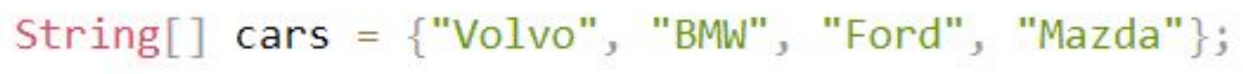


- To declare an array, define the variable type with **square brackets**

```
String[] cars;
```

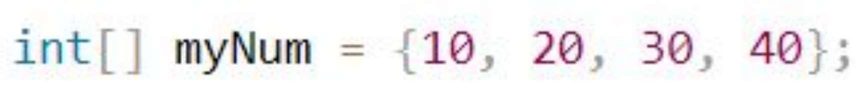
Array

- To insert values to it, we can use an array literal - place the values in a comma-separated list, inside curly braces.



```
String[] cars = {"Volvo", "BMW", "Ford", "Mazda"};
```

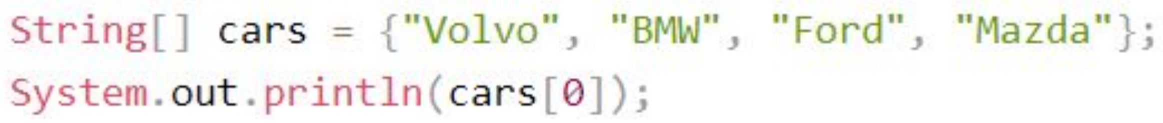
- To create an array of integers, you could write:



```
int[] myNum = {10, 20, 30, 40};
```

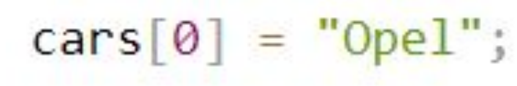
Array

- You access an array element by referring to the index number.



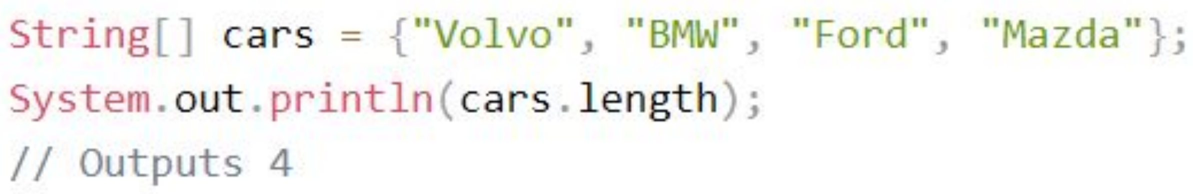
```
String[] cars = {"Volvo", "BMW", "Ford", "Mazda"};
System.out.println(cars[0]);
```

- To change the value of a specific element, refer to the index number:



```
cars[0] = "Opel";
```

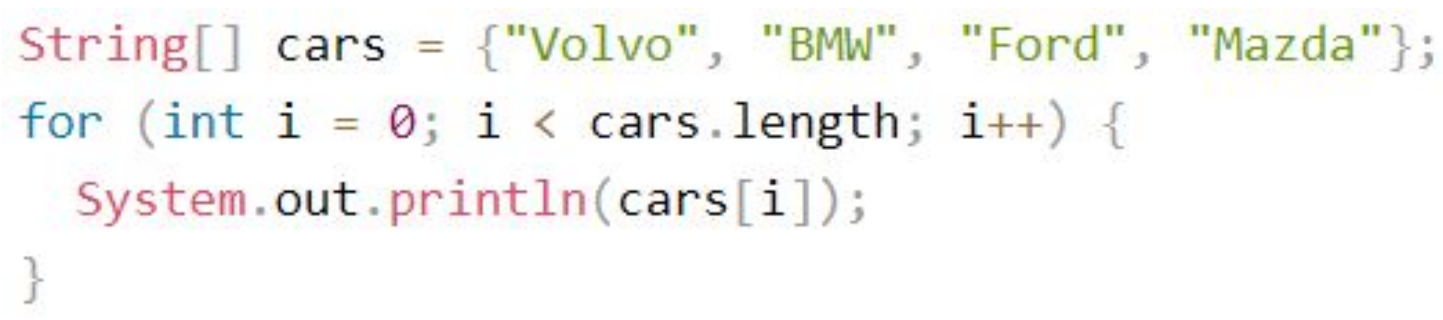
- To find out how many elements an array has, use the ‘length’ property:



```
String[] cars = {"Volvo", "BMW", "Ford", "Mazda"};
System.out.println(cars.length);
// Outputs 4
```

Array

- You can loop through the array elements.

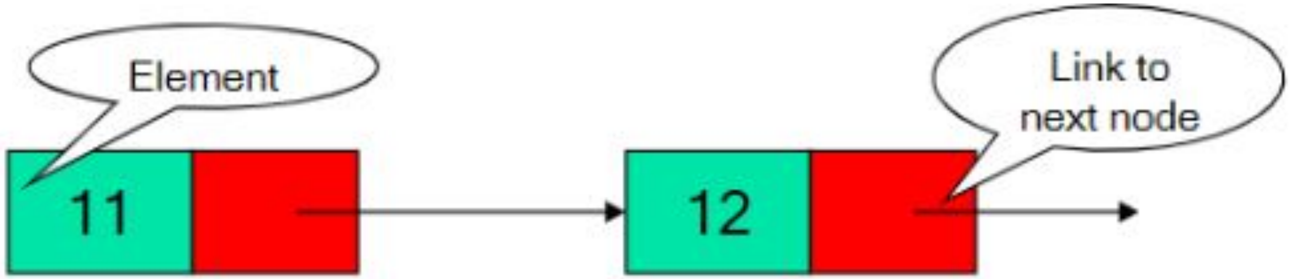


```java
String[] cars = {"Volvo", "BMW", "Ford", "Mazda"};
for (int i = 0; i < cars.length; i++) {
  System.out.println(cars[i]);
}
```

Linked List

Linked List - Introduction

- Linked List is a Linear Data Structure represented by nodes.
- It is made of collection of connected, dynamically allocated Nodes
- Each node will have at least two elements
  - Element (The data)
  - The next node



Why Linked List

- Inserting or Deleting elements into or from list is easy, where it requires extensive data movement if array is used

- Linked List can grow or shrink dynamically based on the size of the list, but in array size is fixed once it is created

Linked List - Types

- Single Linked List
  - Can access the next node only
  - Last Node is set to null
- Doubly Linked List
  - Can access the next and Previous node
  - Last Node is set to null
- Circular Linked List
  - Similar to Doubly linked List, but Last node points to the first node

Header & Trailer Nodes

- Header Node: A placeholder node at the beginning of list, used to simplify list processing. It doesn't hold any data but satisfies that every node has a previous node.

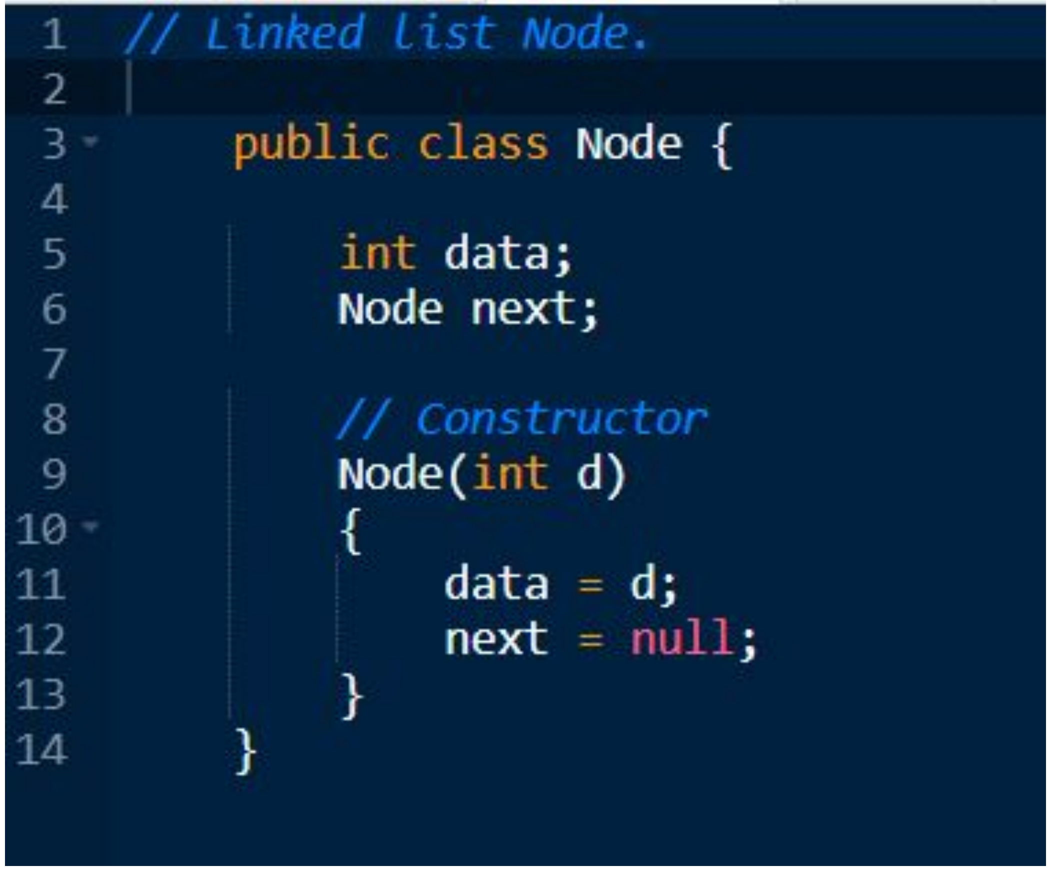
- Trailer Node: A Placeholder node at the end of list, used to simplify list processing.

Linked List Implementation

Linked List - Implementation

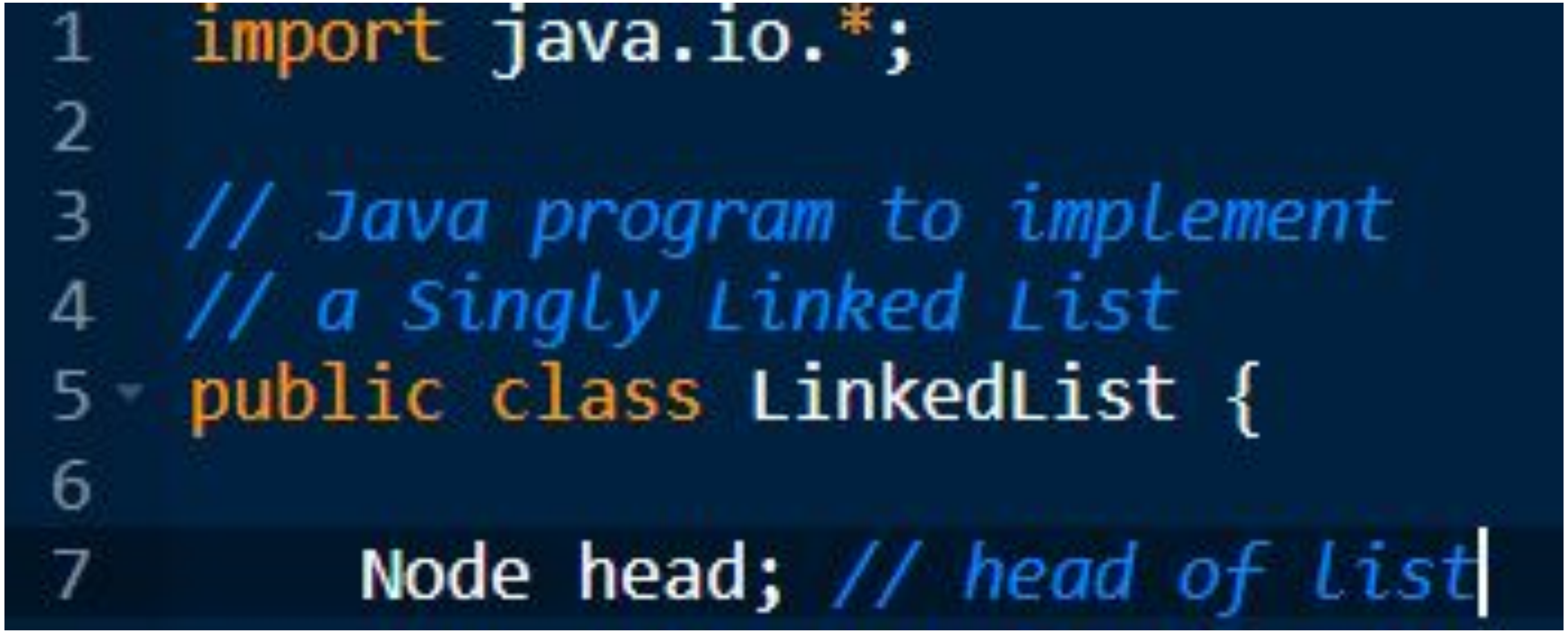
- It requires two classes
  - A class for one Node (Node class)
  - A class for Linked List (LinkedList class)

Node Class



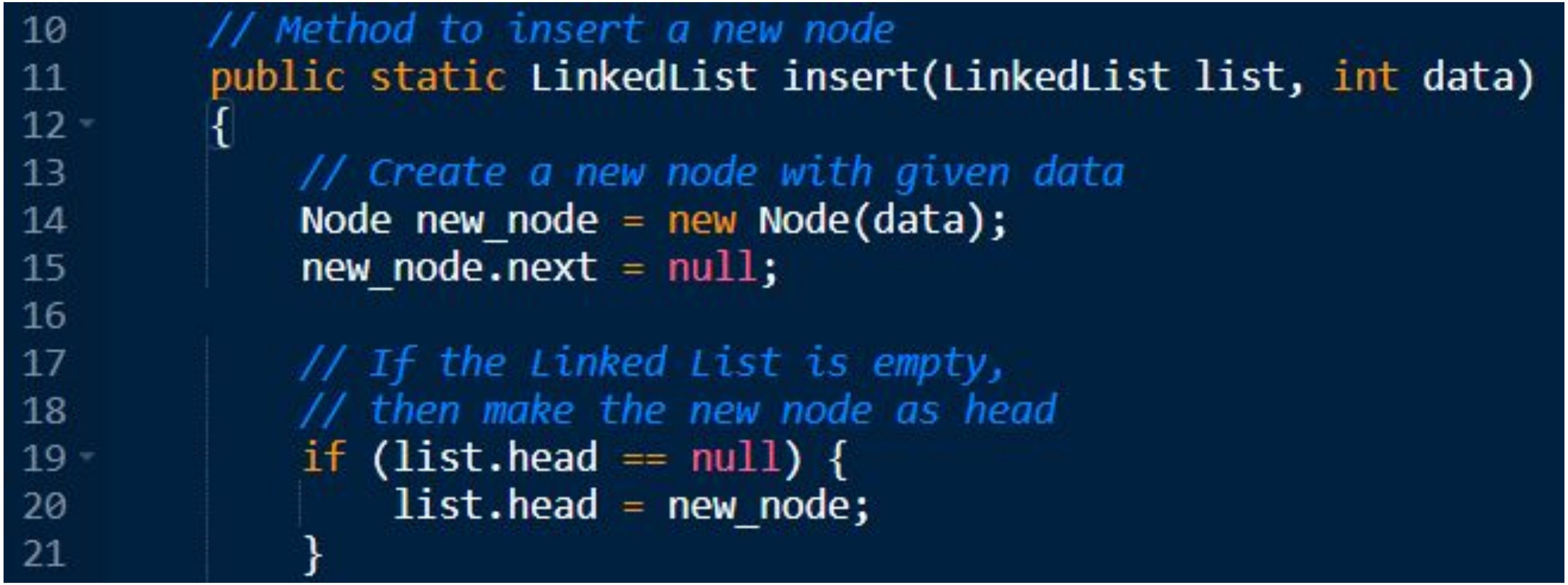
```java
// Linked list Node.

    public class Node {

        int data;
        Node next;

        // Constructor
        Node(int d)
        {
            data = d;
            next = null;
        }
    }
```

Linked List Class



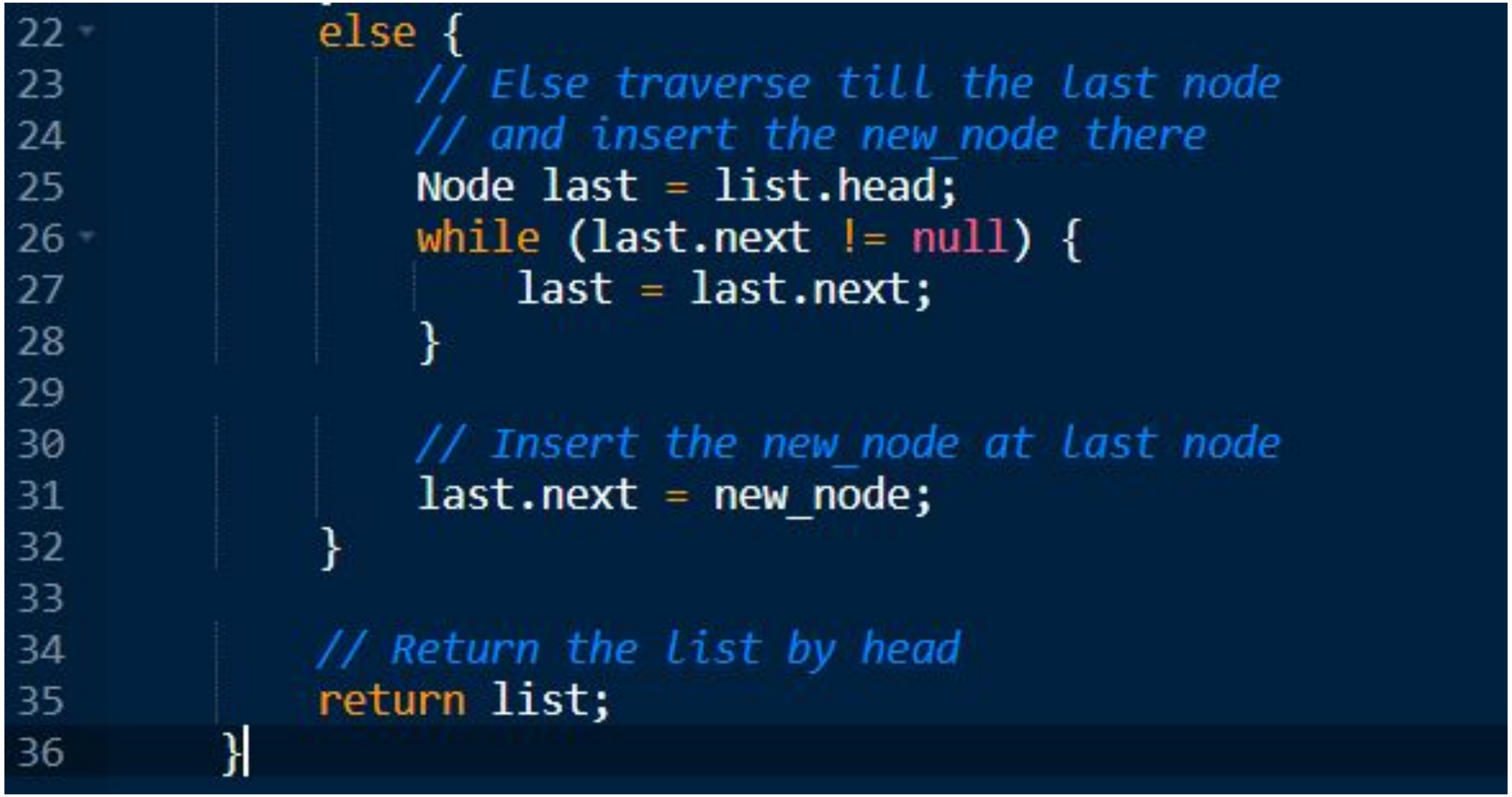
```java
import java.io.*;

// Java program to implement
// a Singly Linked List
public class LinkedList {

    Node head; // head of list
```

Linked List Class – Insert



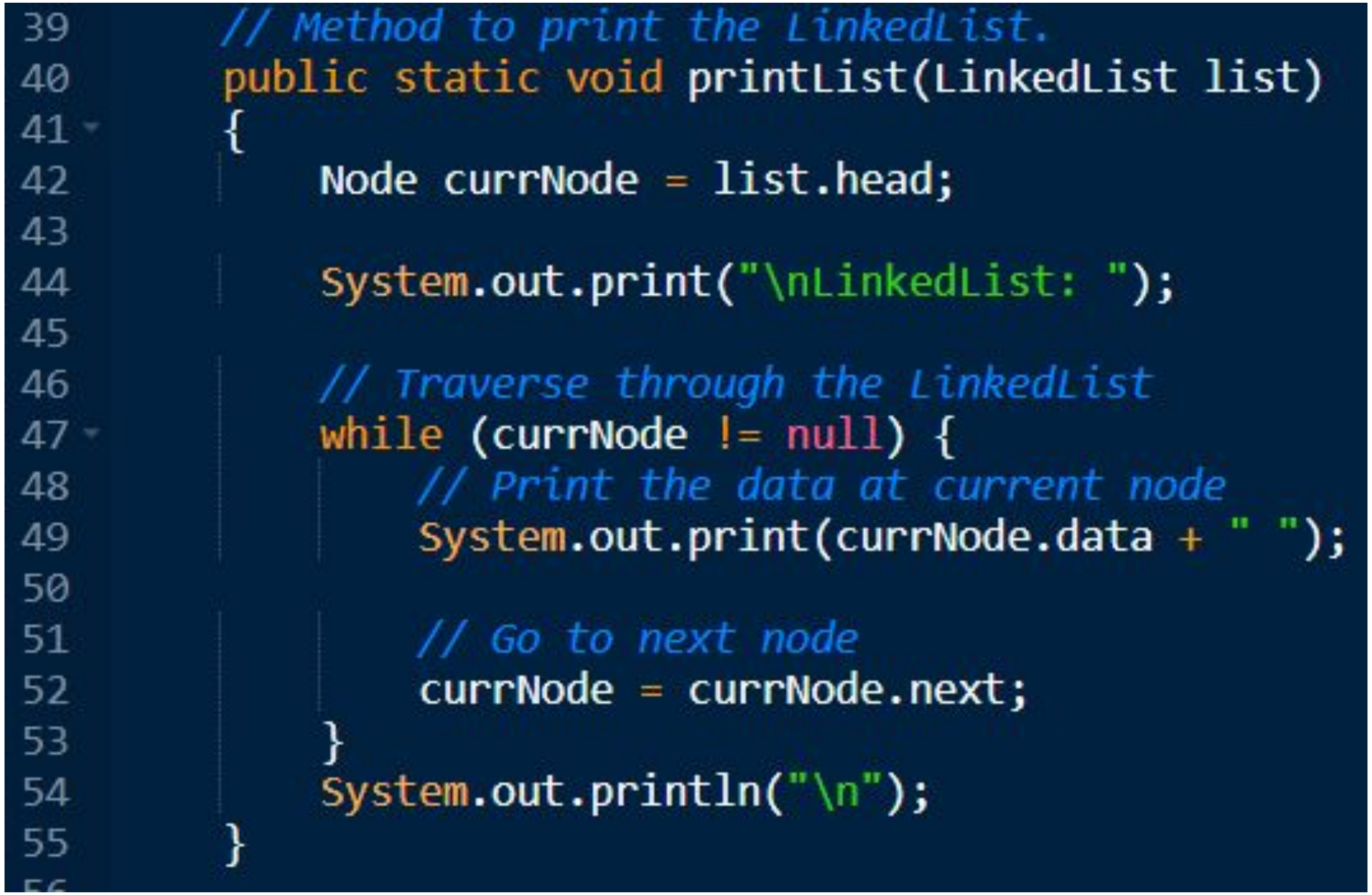
```
    // Method to insert a new node
    public static LinkedList insert(LinkedList list, int data)
    {
        // Create a new node with given data
        Node new_node = new Node(data);
        new_node.next = null;

        // If the Linked List is empty,
        // then make the new node as head
        if (list.head == null) {
            list.head = new_node;
        }
```

Linked List Class - Insert



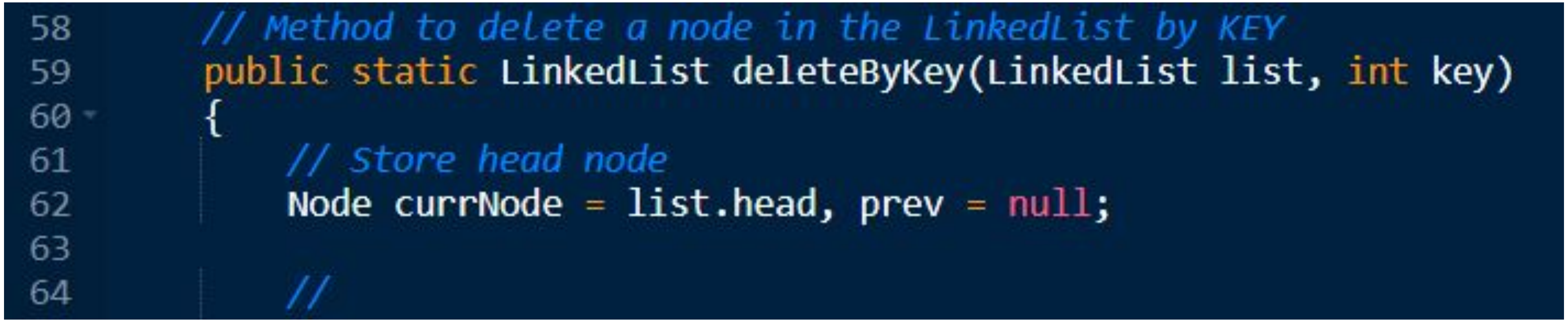
```
        else {
            // Else traverse till the last node
            // and insert the new_node there
            Node last = list.head;
            while (last.next != null) {
                last = last.next;
            }

            // Insert the new_node at last node
            last.next = new_node;
        }

        // Return the list by head
        return list;
    }
```

Linked List Class – Print



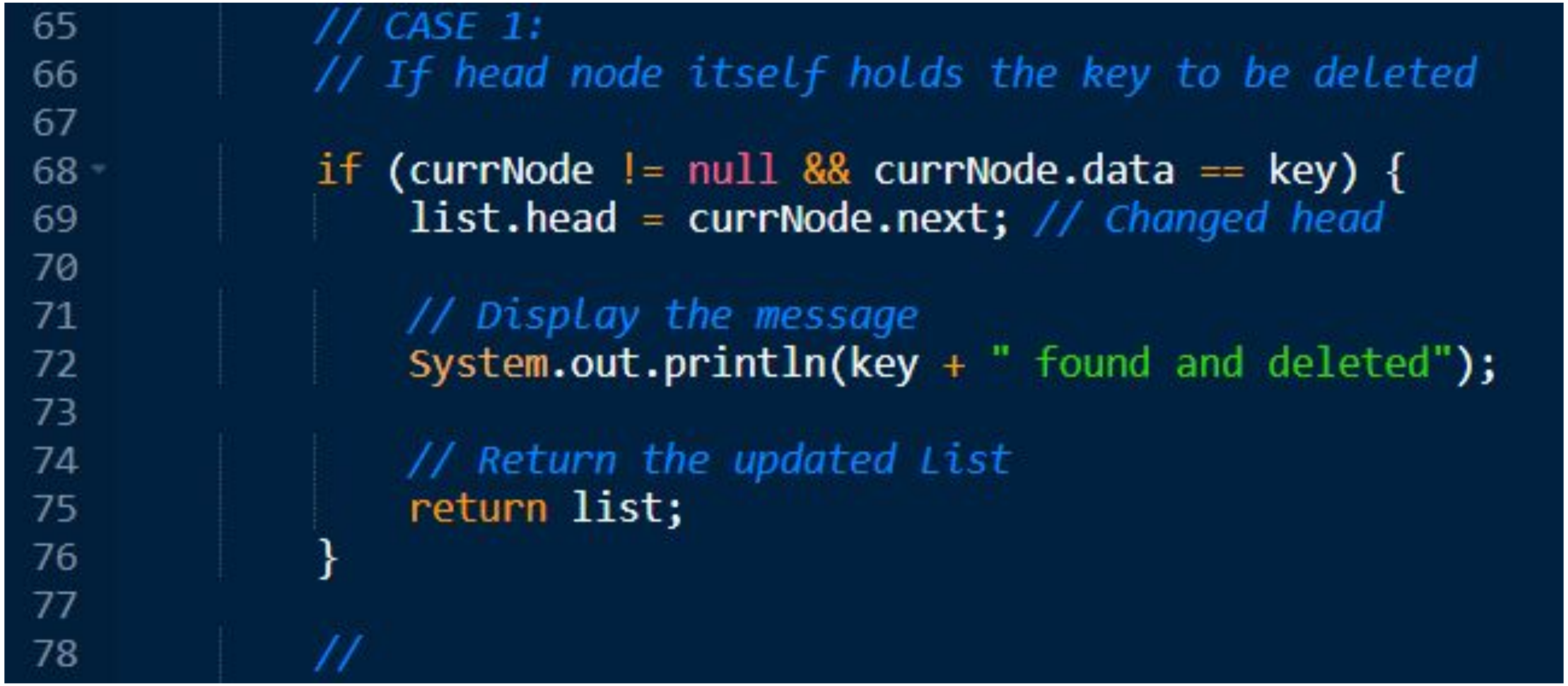
```java
    // Method to print the LinkedList.
    public static void printList(LinkedList list)
    {
        Node currNode = list.head;

        System.out.print("\nLinkedList: ");

        // Traverse through the LinkedList
        while (currNode != null) {
            // Print the data at current node
            System.out.print(currNode.data + " ");

            // Go to next node
            currNode = currNode.next;
        }
        System.out.println("\n");
    }
```

Linked List Class - Delete



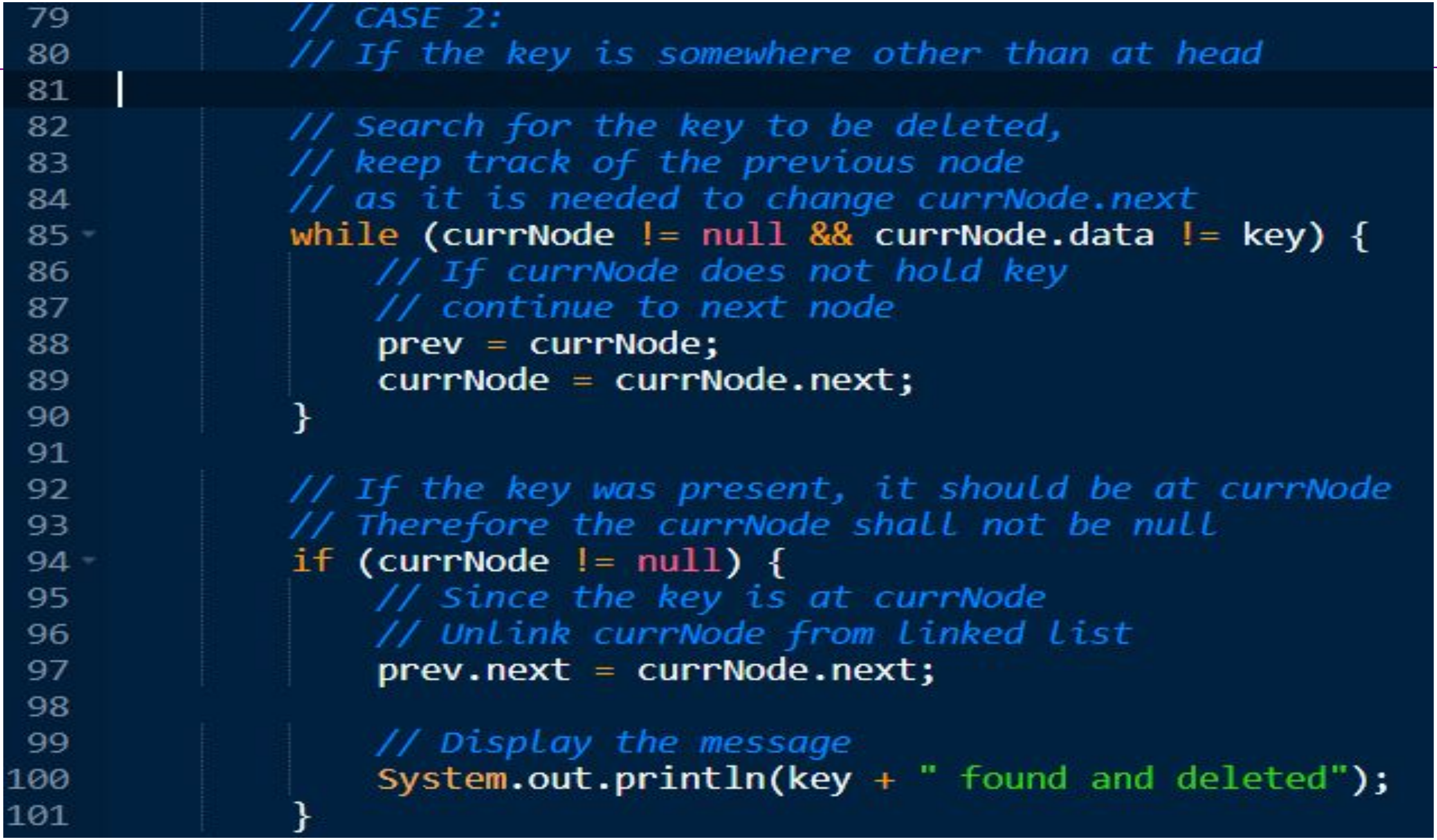
```
    // Method to delete a node in the LinkedList by KEY
    public static LinkedList deleteByKey(LinkedList list, int key)
    {
        // Store head node
        Node currNode = list.head, prev = null;

        //
```

Linked List Class - Delete



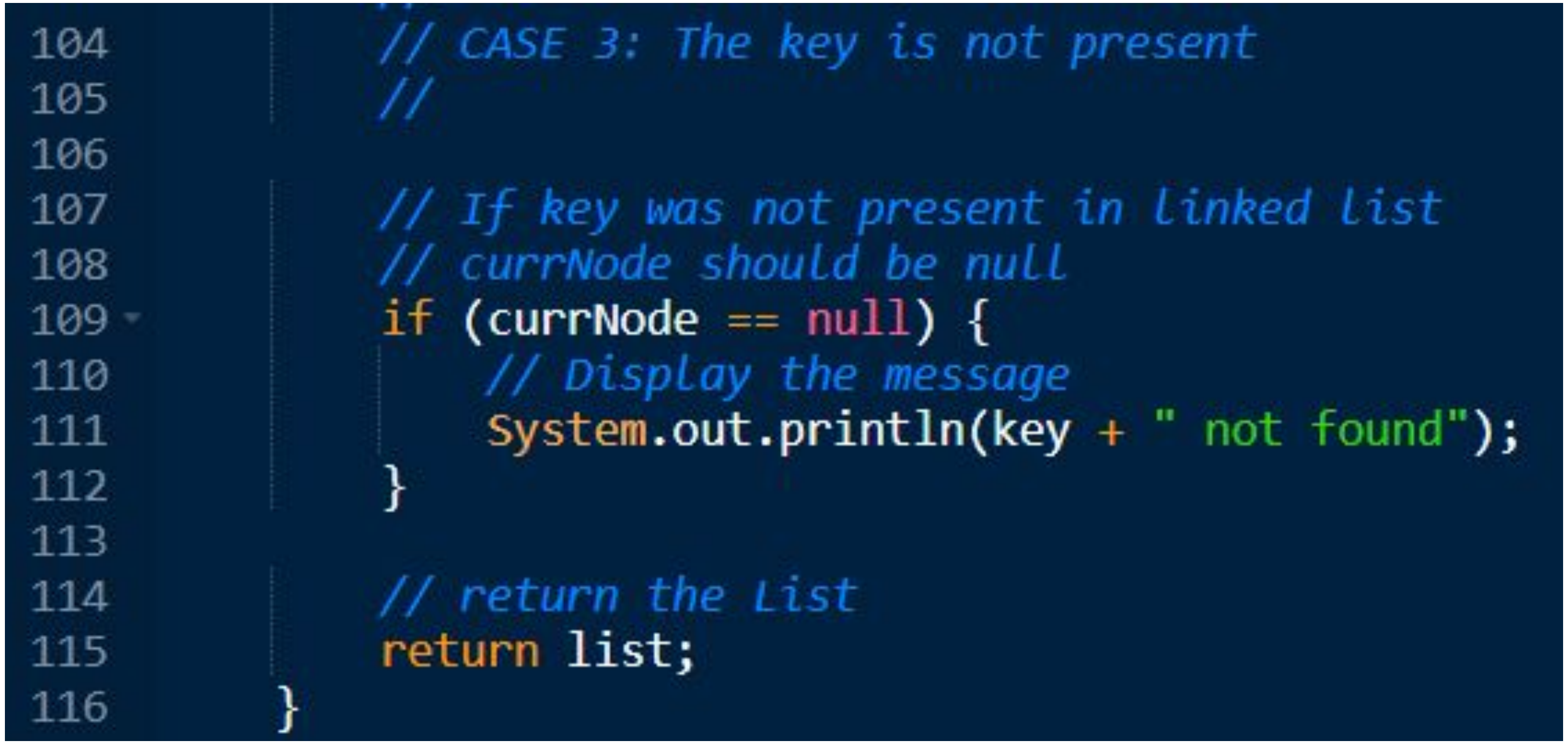
```
        // CASE 1:
        // If head node itself holds the key to be deleted

        if (currNode != null && currNode.data == key) {
            list.head = currNode.next; // Changed head

            // Display the message
            System.out.println(key + " found and deleted");

            // Return the updated List
            return list;
        }

        //
```

Linked List Class - Delete



```
        // CASE 2:
        // If the key is somewhere other than at head

        // Search for the key to be deleted,
        // keep track of the previous node
        // as it is needed to change currNode.next
        while (currNode != null && currNode.data != key) {
            // If currNode does not hold key
            // continue to next node
            prev = currNode;
            currNode = currNode.next;
        }

        // If the key was present, it should be at currNode
        // Therefore the currNode shall not be null
        if (currNode != null) {
            // Since the key is at currNode
            // Unlink currNode from linked list
            prev.next = currNode.next;

            // Display the message
            System.out.println(key + " found and deleted");
        }
```

Linked List Class - Delete



```
    // CASE 3: The key is not present
    //

    // If key was not present in linked list
    // currNode should be null
    if (currNode == null) {
        // Display the message
        System.out.println(key + " not found");
    }

    // return the List
    return list;
}
```