Methodic and Practical Foundations of Computer Science 1

14-Data_Structure

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Data Structure and Algorithms

- A data structure is an arrangement of data in a computers memory (or sometimes on a disk).
- Data structures include linked lists, stacks, binary trees, and hash tables.
- Algorithms manipulate the data in these structures in various ways, such as inserting a new data item, searching for a particular item, or sorting the items. Genrally data structure is the Arrangement of data in a computers memory.

Overview on Algorithms

- An algorithm can be thought of as the detailed instructions for carrying out some operation For most data structures, you must know how to do the following:
    1. Insert a new data item.
    2. Search for a specified item.
    3. Delete a specified item.

Data Structure vs. Algorithm

- Data structure is concerned with holding data in memory efficiently.
- Algorithms tell you how to store, retrieve, search or alter data in a data structure.

Data Structure Solving Problems

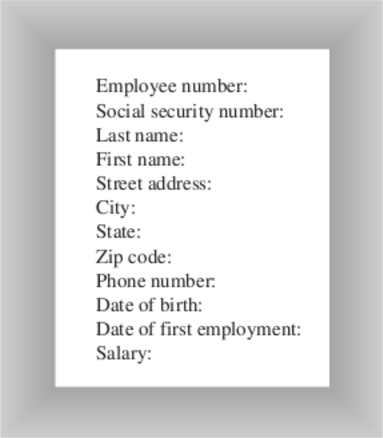
- What sort of problem can you solve with using a Data Structure:
    - Real-world Data Storage: real-world data describes physical entities external to the computer.
    - Some examples are a personnel record that describes an actual human being, an inventory record that describes an existing car part or grocery item, and a financial transaction record that speak about bills.

Some Initial Definitions

1. **Datafile**: refers to a collection of similar data items. As an example, if you create an address book the collection of cards you have created constitutes a datafile.
2. **Record**: A record includes all the information about some entity, in a situation in which there are many such entities. A record might correspond to a person in a **personnel file**, **a recipe in a cookbook file**.
3. **Field**: A record is usually divided into several fields. A field holds a particular kind of data like a persons name.

Record Example

- A Record with multiple Fields



Employee number:
Social security number:
Last name:
First name:
Street address:
City:
State:
Zip code:
Phone number:
Date of birth:
Date of first employment:
Salary:

The Advantages of lists

- Lists can dynamically grow and shrink
- Lists are rather easy to implement
- Adding/removing elements to/from the beginning/end of a list can be fast

Linked List

1. Second most commonly used storage structure after arrays
2. Suitable to use in many general-purpose databases.
3. Size of a list can be increased during execution
4. To delete a list item does not need much efforts

What is link?

- Each data item is fixed in a link.
- A link is an object of a class usually called Link.
- Each link object contains a reference called next, and one or more data items
- The last list element is always connected to null.

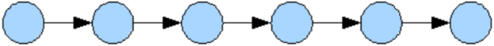
Linked List

There are two types of linked list:

1. Singly linked list
2. Double linked list

Singly Linked List

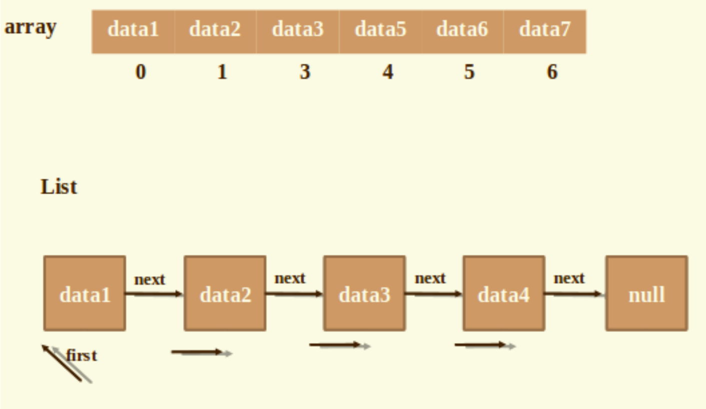
- Singly linked lists are a **linear data structure**.
- Each element has at most one successor, and the last element has no successor.



Linked List vs. Array

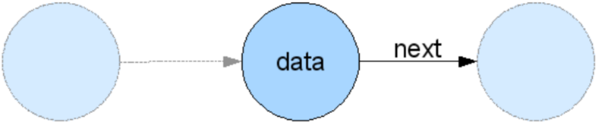
1. Each item of an array occupies a position in the memory. With indexes we can reach the item.
2. Each list element is stored somewhere in the memory and they are connected to each other through a reference.
3. To reach a list element you have to move along the chain of element

Linked List vs. Array



List Information

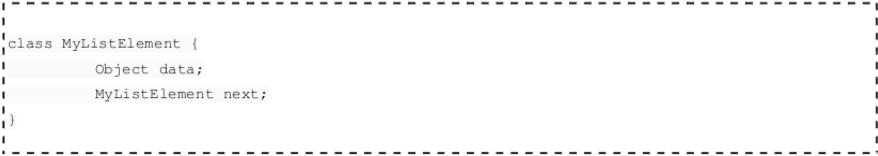
- List elements must store the following information:



- A reference to the data that is represented by the list element
- A reference to the next list element (if it exists)
- Next is a self-refrential variable
- Each Node sotres: element and link to the next node
- It is possible to store additional information in the list elements (such as the predecessor) for convenience.

Singly Linked List

- In Java, each list element is an object



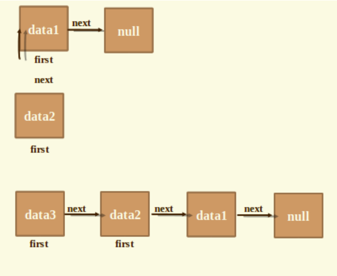
```
class MyListElement {
         Object data;
         MyListElement next;
}
```

- The list elements can then be organized into a list, which contains a reference to the first element and exposes methods to manipulate the list.

Common Operations on Lists

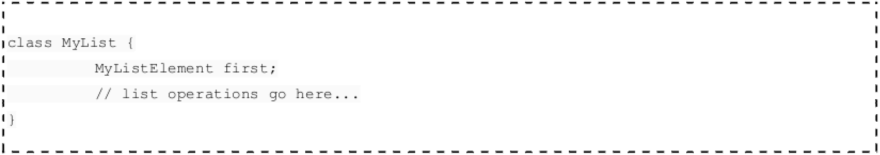
- **addFirst();** to add in the beginning
- **addLast();** to add at the end
- **addAtPosition();** to add in a specified position
- **search();** to search for an element
- **deleteFirst();** to delete the first element
- **deleteLast();** to delete the last element
- **deleteAtPosition();** to delete a specific element
- **printList();** to print list elements

addFirst(data);

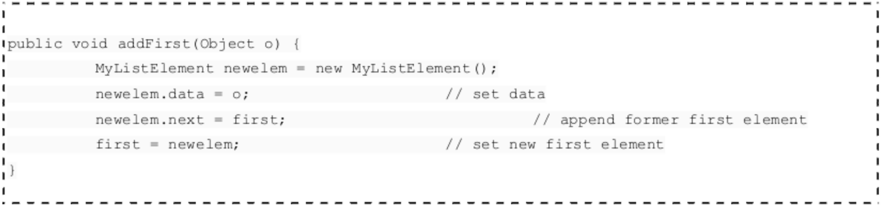


- **addFirst():** Inserts a new element at the beginning

addFirst() Implementation

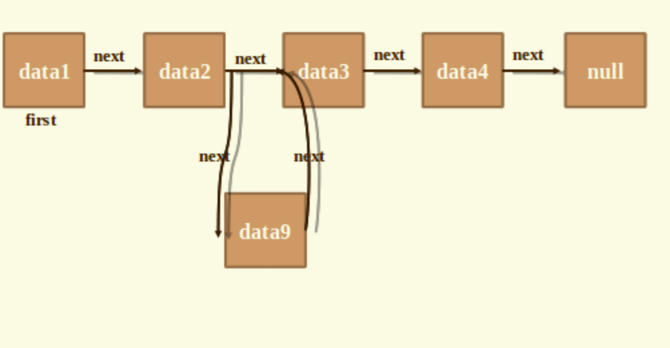


```
class MyList {
        MyListElement first;
        // list operations go here...
}
```



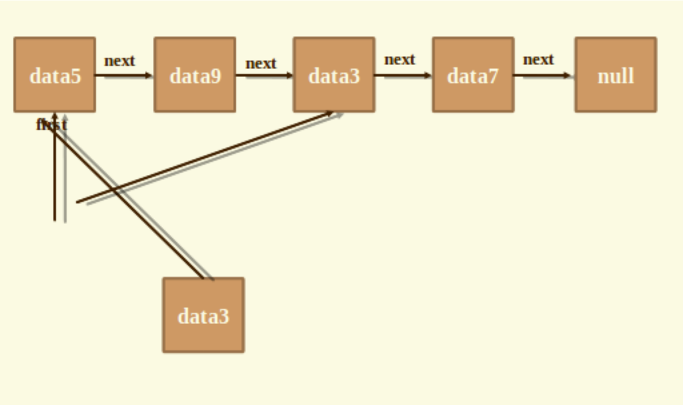
```
public void addFirst(Object o) {
        MyListElement newelem = new MyListElement();
        newelem.data = o;                    // set data
        newelem.next = first;                        // append former first element
        first = newelem;                     // set new first element
}
```

addAtPosition(data,position)

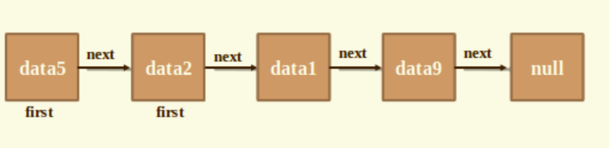


getElementAT()

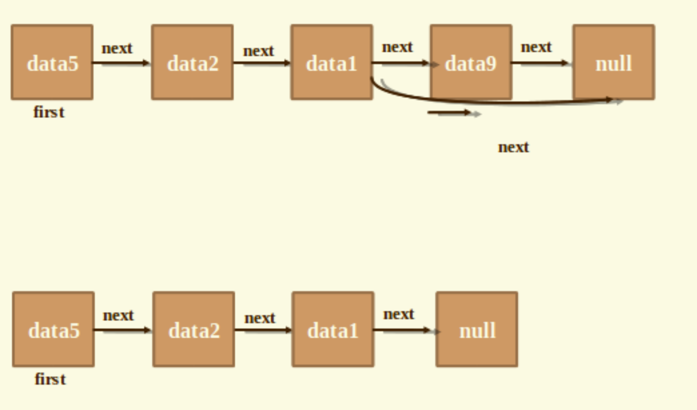
- getElementAT(): Returns the element at the specified position in the list.



deleteFirst()

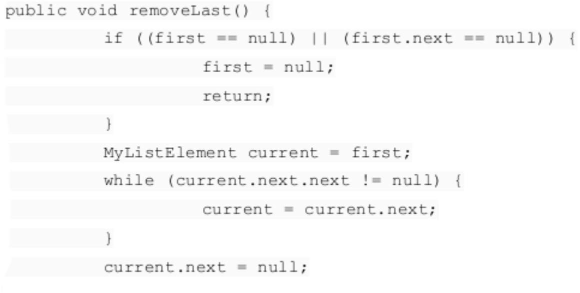


deleteLast();


data5
next
data2
next
data1
next
data9
next
null
first
next
data5
next
data2
next
data1
next
null
first

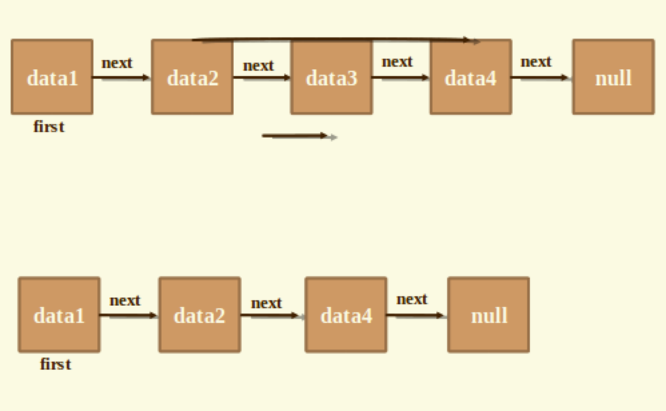
deleteLast();

- Certain operations, such as removing the last element of a list, require going through the entire list. This is inefficient.



```
public void removeLast() {
        if ((first == null) || (first.next == null)) {
                first = null;
                return;
        }
        MyListElement current = first;
        while (current.next.next != null) {
                current = current.next;
        }
        current.next = null;
```

deleteAtPosition();



Question