Data Structure and Algorithms

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Linked List – Advantages

- Access any item as long as external link to first item maintained
- Insert new item without shifting
- Delete existing item without shifting
- Can expand/contract (flexible) as necessary

Linked List – Disadvantages

- Overhead of links
  - Used only internally, pure overhead
- If dynamic, must provide
  - Destructor
  - Copy constructor
  - Assignment operator
- No longer have direct access to each element of the list
  - Many sorting algorithms need direct access
  - Binary search needs direct access
- Access of nth item now less efficient
  - Must go through first element, then second, and then third, etc.

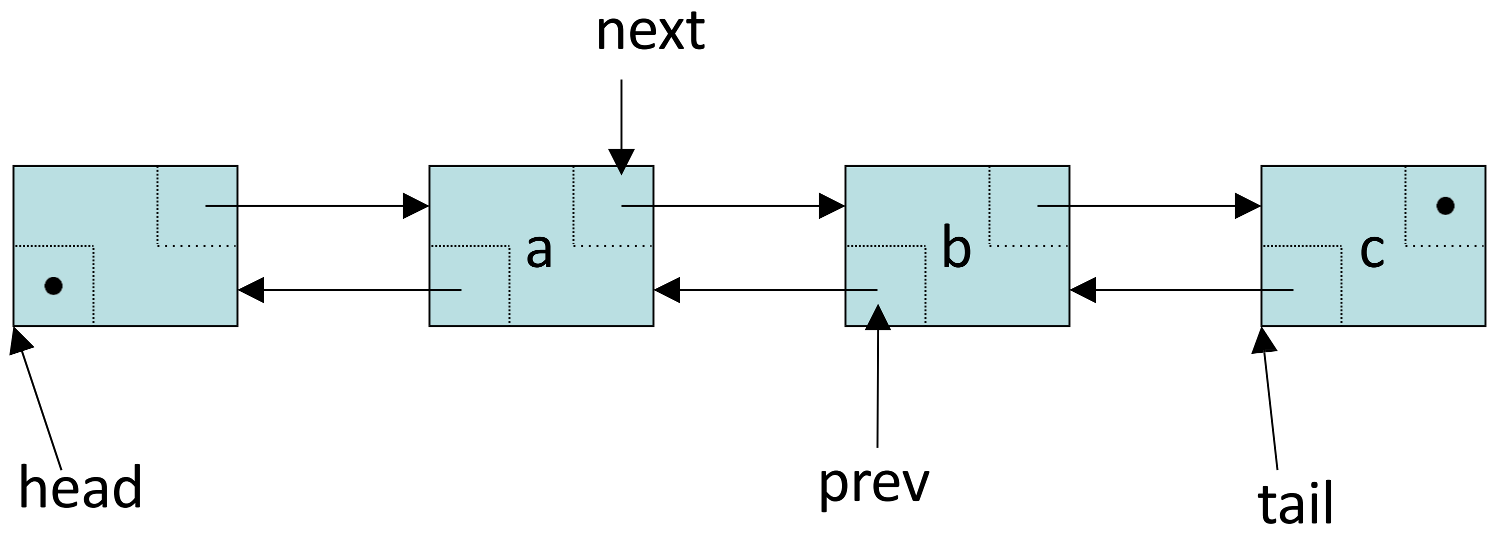
Some Applications

- Applications that maintain a Most Recently Used (MRU) list
  - For example, a linked list of file names
- Cache in the browser that allows to hit the BACK button
  - A linked list of URLs
- Undo functionality in Photoshop or Word
  - A linked list of state
- A list in the GPS of the turns along your route

Can we traverse the linked list in the reverse direction!

Doubly Linked List

- Every node contains the address of the previous node except the first node
  - Both forward and backward traversal of the list is possible



Node Class

- DoubleListNodeclass contains three data members
  - data: double-type data in this example
  - next: a pointer to the next node in the list
  - Prev: a pointer to the pervious node in the list

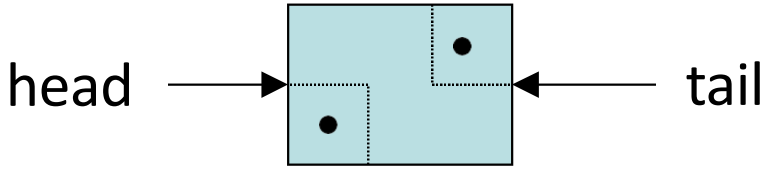
```
class DoubleListNode {
public:
      double data;
      DoubleListNode * next;
      DoubleListNode * prev;
};
```

List Class

- List class contains two pointers
  - head: a pointer to the first node in the list
  - tail: a pointer to the last node in the list
  - Since the list is empty initially, headand tailare set to NULL

```
class  List {
     public:
          List(void) {
            head = NULL;
            tail = NULL; }
          ~List(void);
          . . .
     private:
          DoubleListNode * head;
          DoubleListNode * tail; };
```

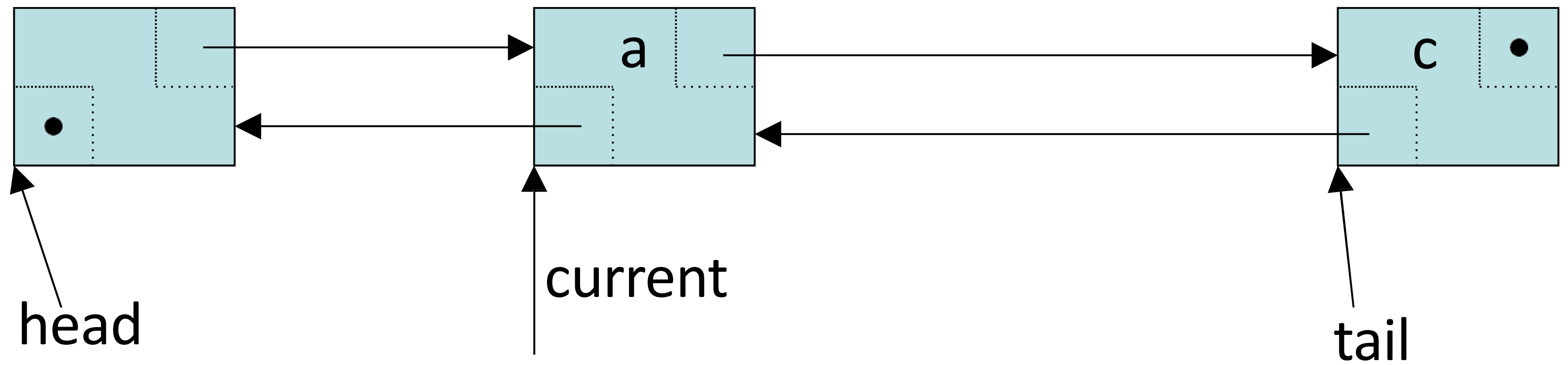
Adding First Node



```
head = new  DoubleListNode;
head->next = null;
head->prev = null; tail =
head;
```

Inserting a Node in Doubly Linked List

- To add a new item after the linked list node pointed by current



```
newNode = new  DoublyLinkedList;
Node newNode->prev = current;
newNode->next = current->next;
newNode->prev->next = newNode;
newNode->next->prev = newNode;
current = newNode;
```

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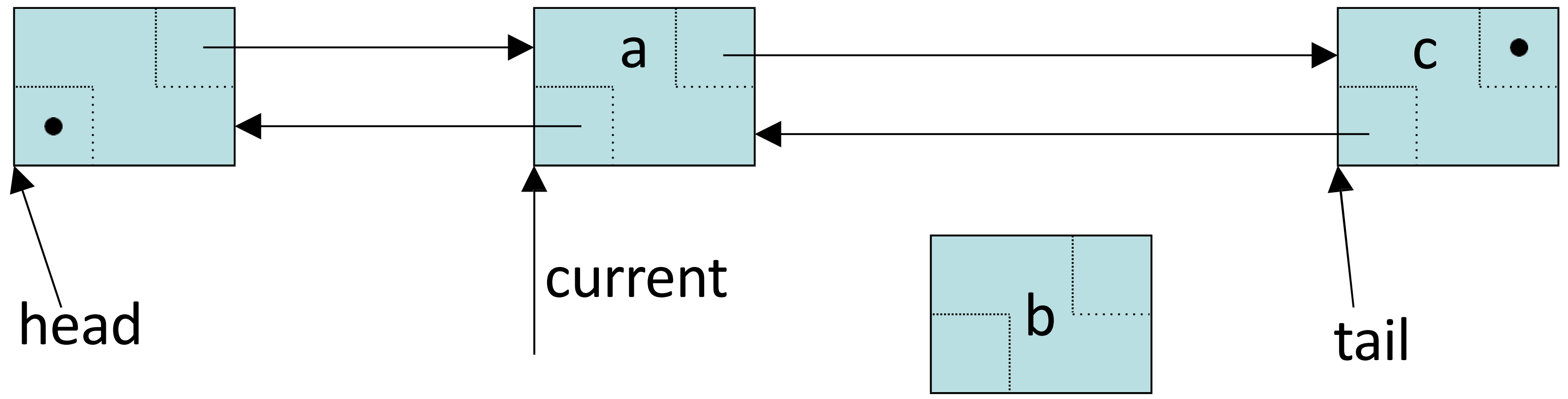

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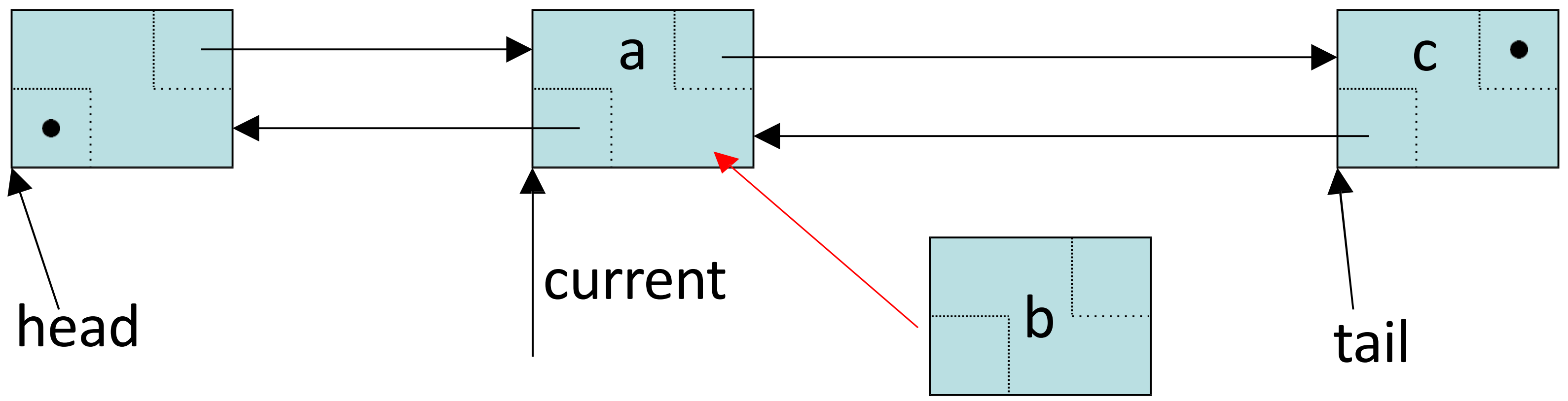

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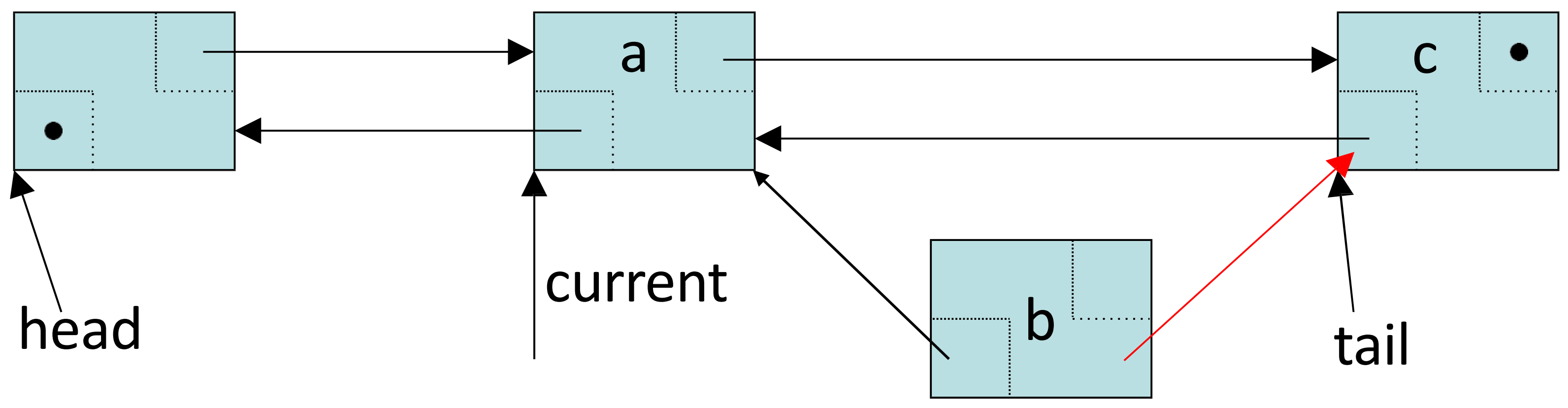

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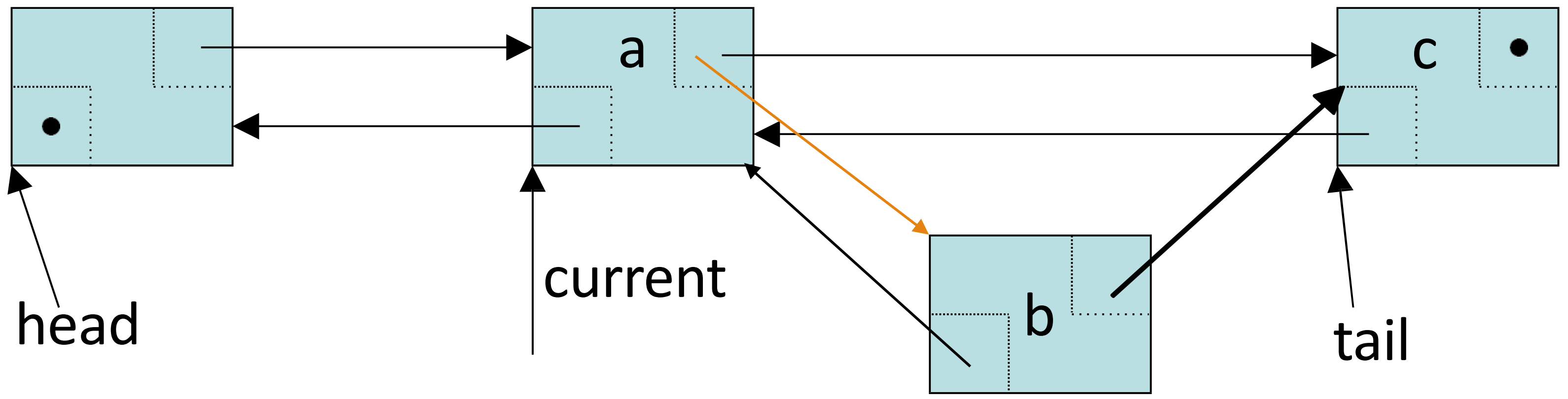

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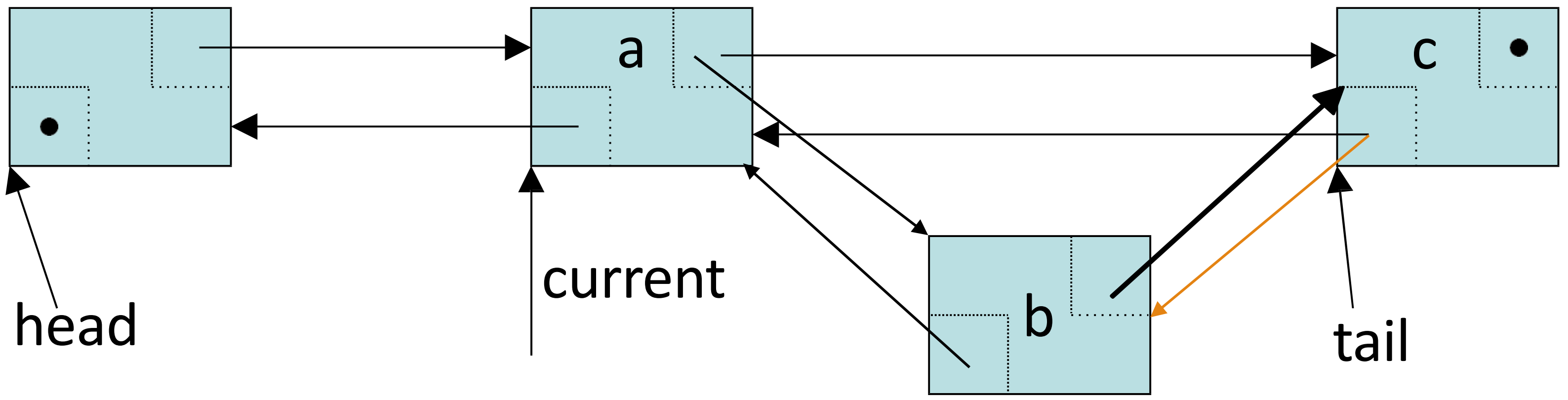

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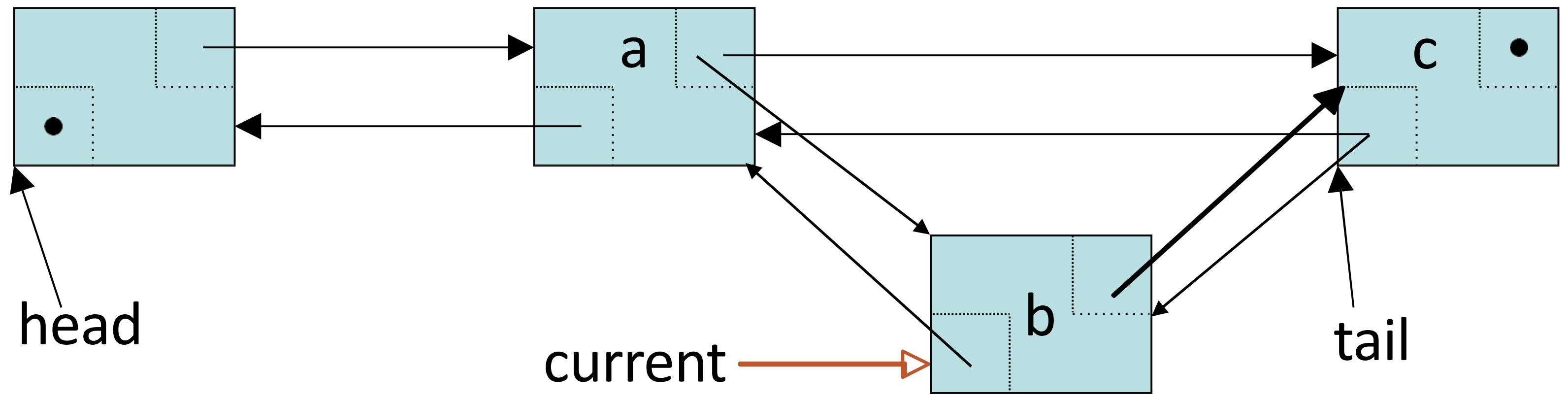

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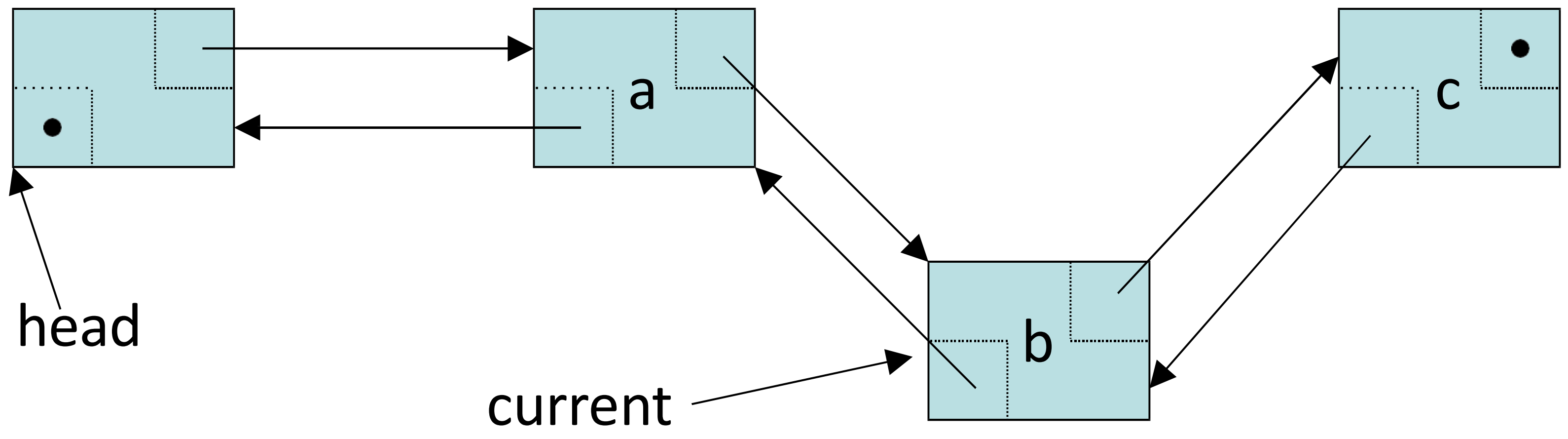
Deleting a Node From Doubly Linked List

- Suppose current points to the node to be deleted from the list



oldNode = current;
oldNode->prev->next = oldNode->next;
oldNode->next->prev = oldNode->prev; current = oldNode->prev;
delete oldNode;

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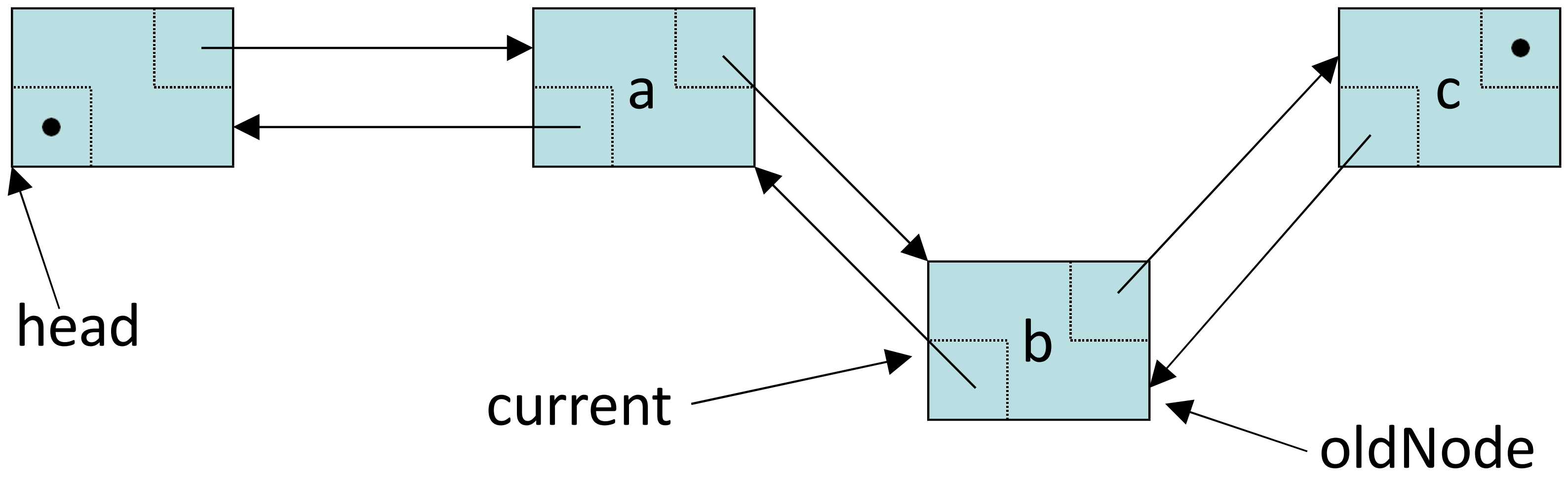

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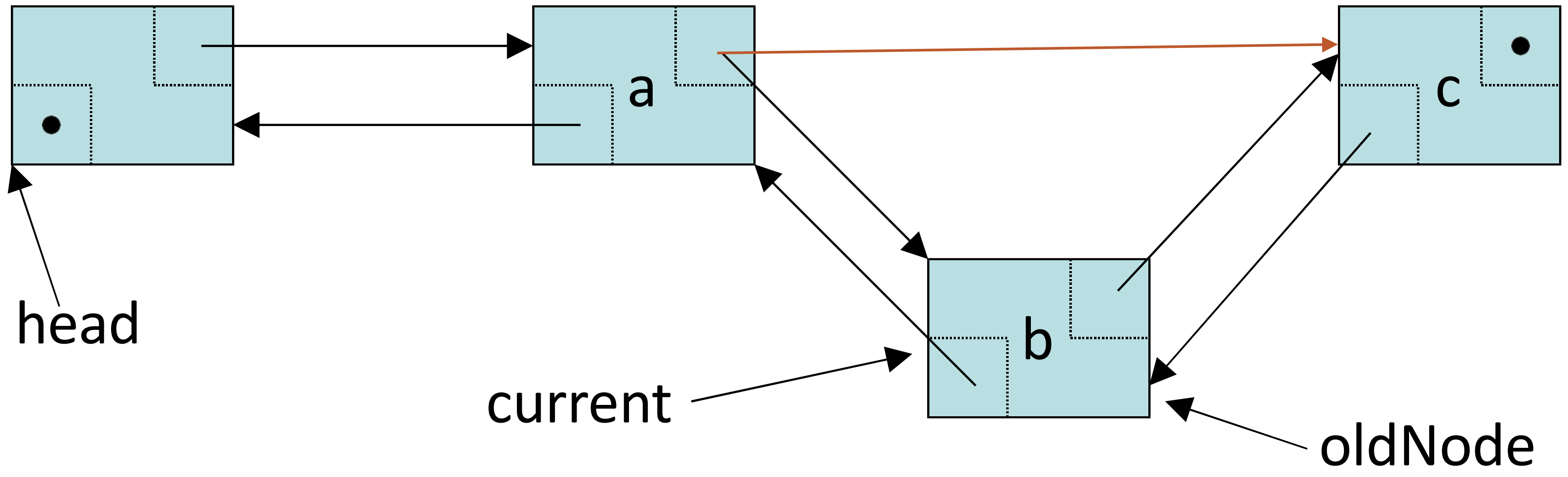

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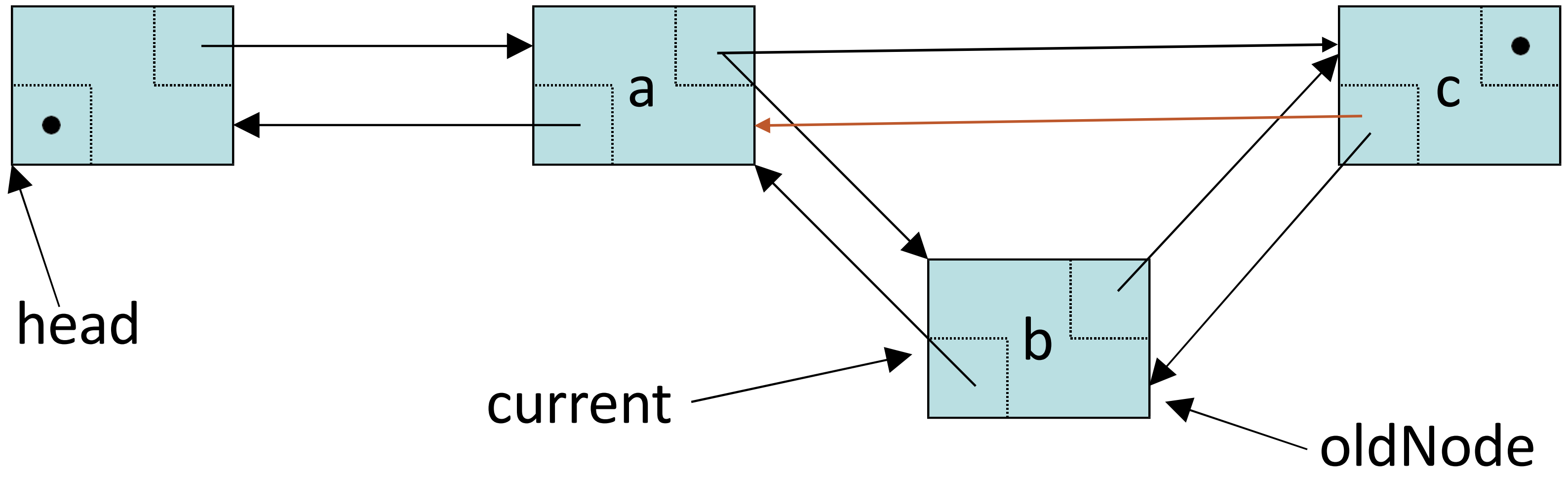

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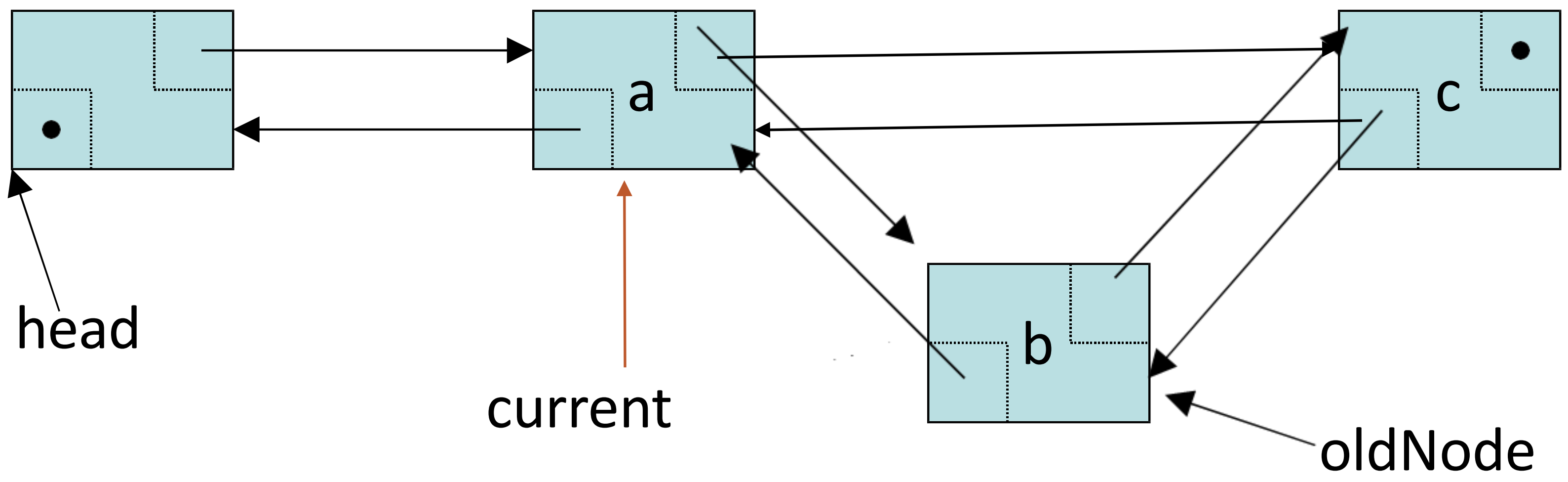

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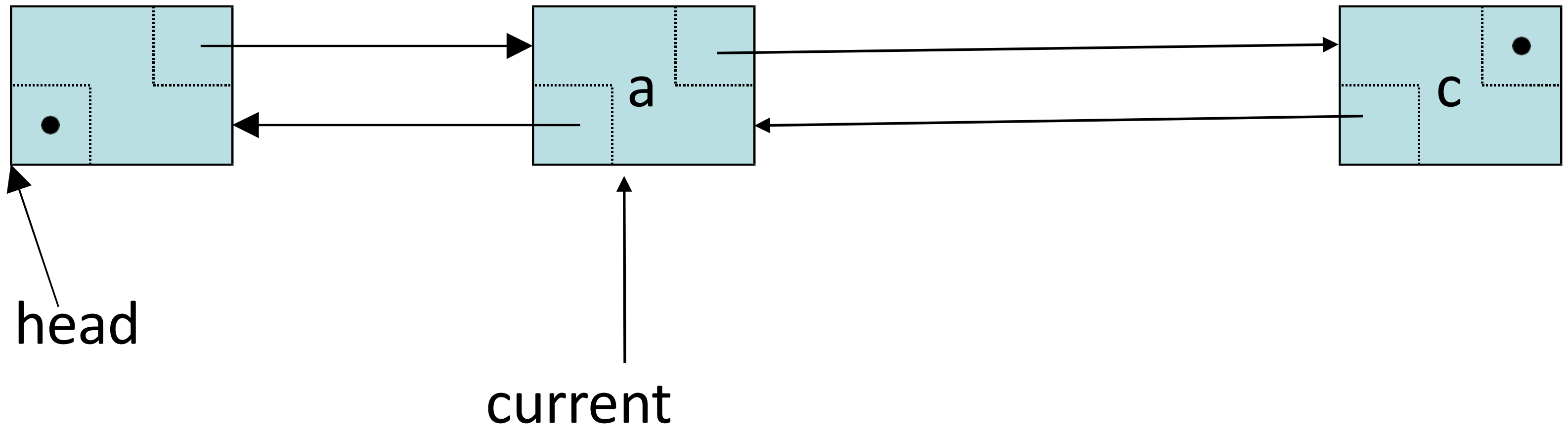
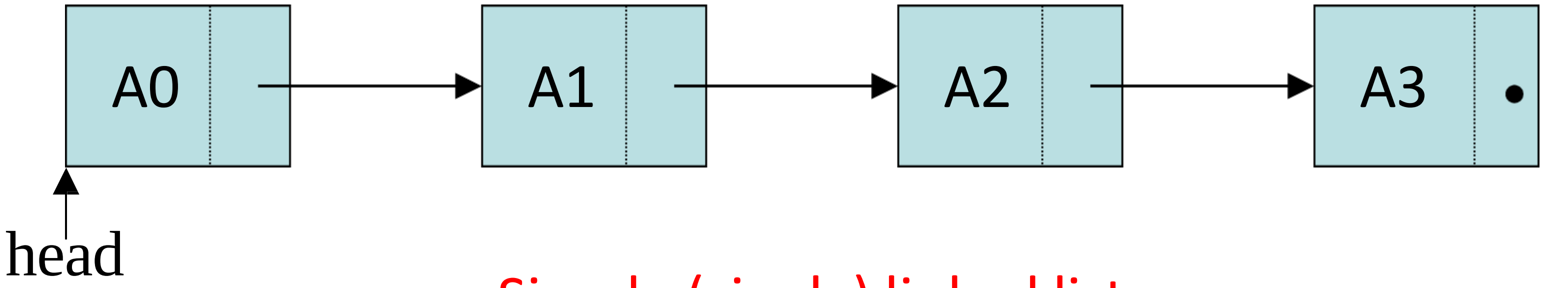
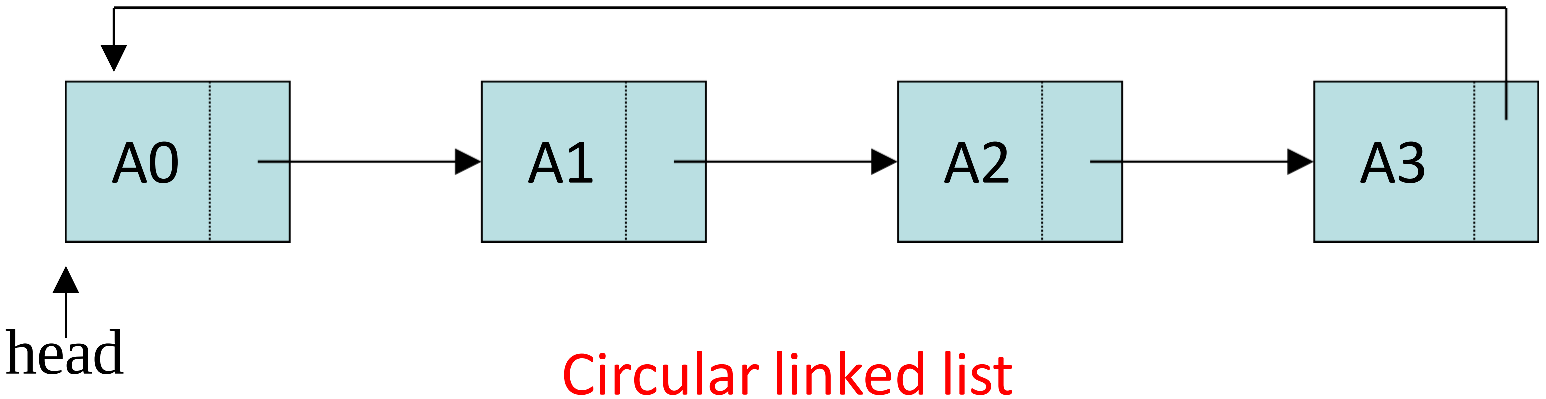


```
oldNode = current;
oldNode->prev->next = oldNode->next;
oldNode->next->prev  =  oldNode->prev;
current  =  oldNode->prev;
delete oldNode;
```

Circular Linked List



Simple (singly) linked list



Circular linked list

- A linked list in which the last node points to the first node

Advantages of Circular Linked List

- Whole list can be traversed by starting from any point
  - Any node can be starting point
  - What is the stopping condition?
- Fewer special cases to consider during implementation
  - All nodes have a node before and after it
- Used in the implementation of other data structures
  - Circular linked lists are used to create circular queues
  - Circular doubly linked lists are used for implementing Fibonacci heaps

Disadvantages of Circular Linked List

- Finding end of list and loop control is harder
  - No NULL's to mark beginning and end

Any Question So Far?