Copy Constructor

Copy Constructor

1. Initialize one object from another of the same type

```
MyClass one;
MyClass two = one;
```

More explicitly

```
MyClass one;
MyClass two(one); // Identical to above.
```

Creates a **new object** as a copy of another one

Compiler will provide one but may not appropriate for complex objects

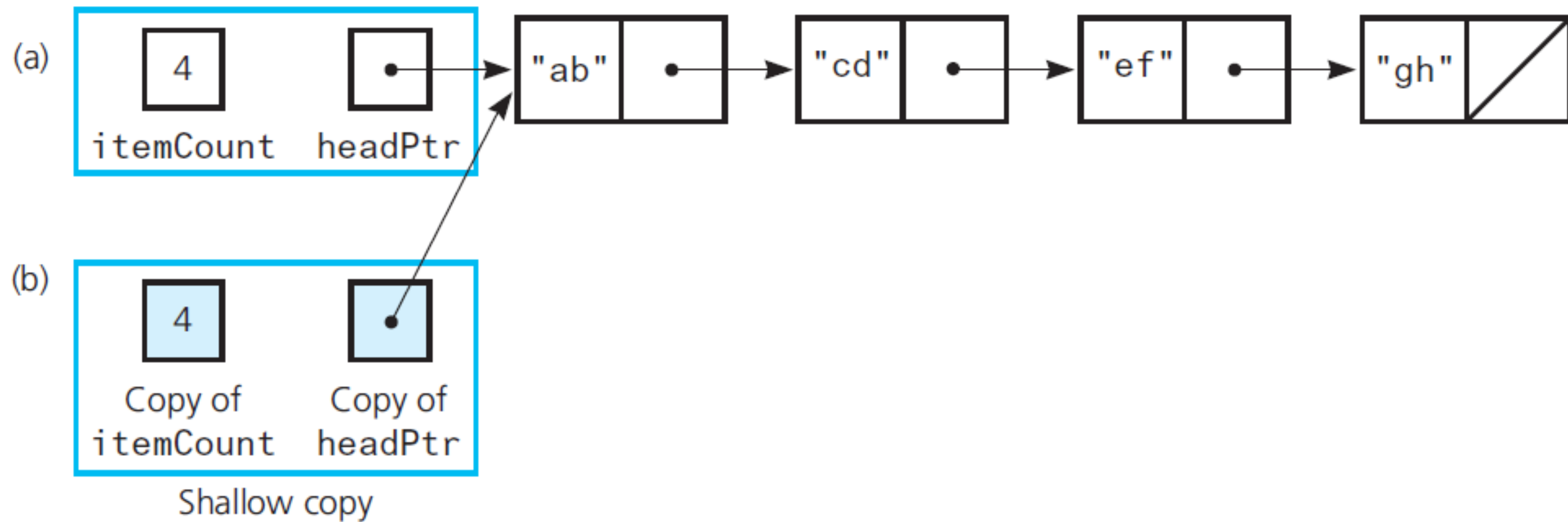
2. Copy an object to **pass by value** as an argument to a function

```
void MyFunction(MyClass arg) {
        /* ... */
}
```

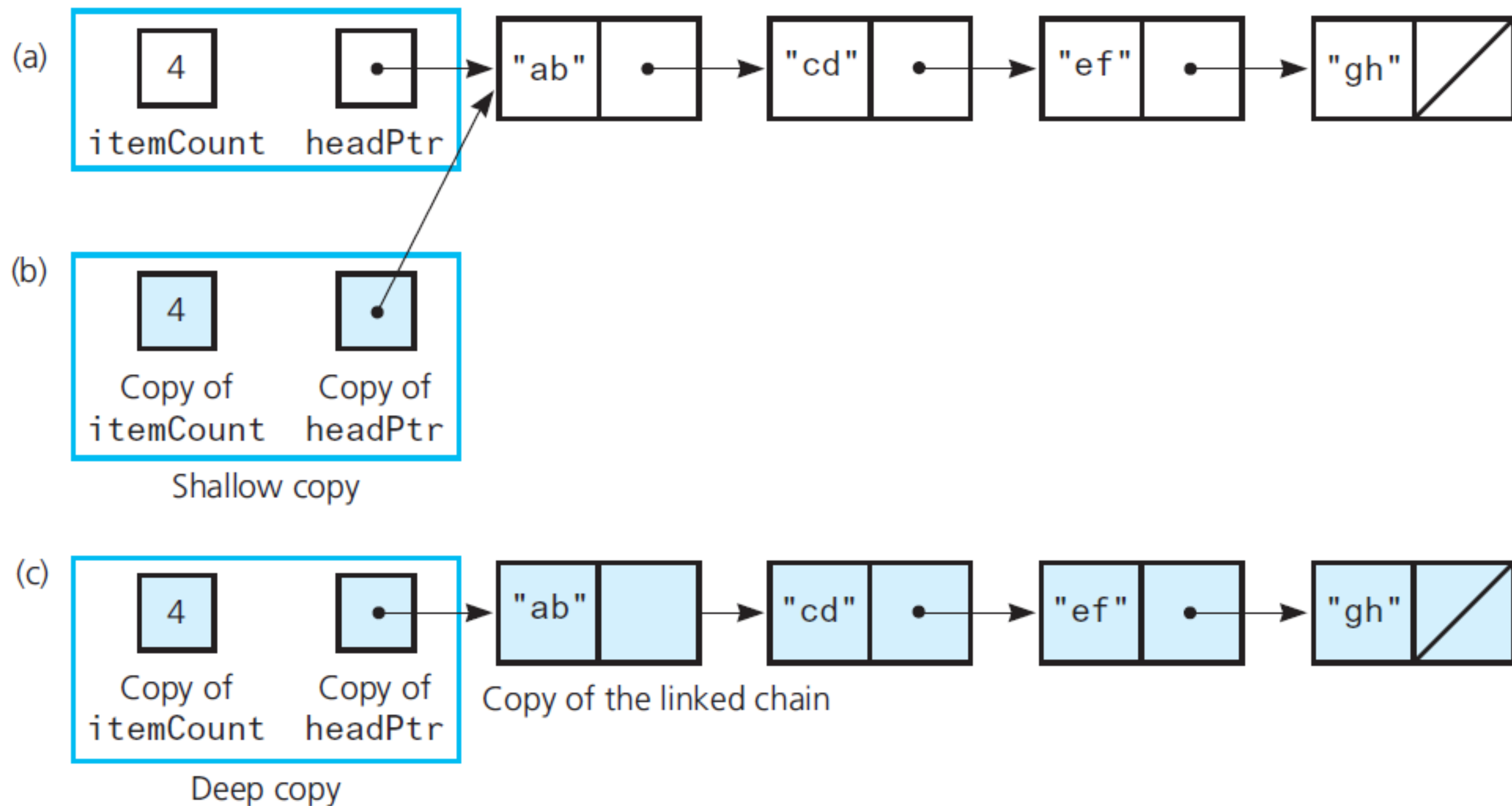
3. Copy an object to be **returned** by a function

```
MyClass MyFunction() {
   MyClass mc;
   return mc;
}
```

Deep vs Shallow Copy



Deep vs Shallow Copy



Overloaded operator=

```
MyClass one;
//Stuff here
MyClass two = one;
```

Instantiation: copy constructor is called

IS DIFFERENT FROM

```
MyClass one, two;
//Stuff here
two = one;
```

Assignment, NOT instantiation: no constructor is called, must overload `operator=` to avoid shallow copy

Copy Constructor Implementation

A constructor whose parameter is an object of the same class

```
#include "LinkedBag.hpp"
template<typename ItemType>
LinkedBag<ItemType>::LinkedBag(const LinkedBag<ItemType>& a_bag)
{
   item_count_ = a_bag.item_count_;
   Node<ItemType>* orig_chain_ptr = a_bag.head_ptr_;//Points to nodes in original chain
   if (orig_chain_ptr == nullptr)
      head_ptr_ = nullptr;  // Original bag is empty
   else
   {
      // Copy first node
      head_ptr_ = new Node<ItemType>();
      head_ptr_->setItem(orig_chain_ptr->getItem());
      // Copy remaining nodes
      Node<ItemType>* new_chain_ptr = head_ptr_;//Points to last node in new chain
      orig_chain_ptr = orig_chain_ptr->getNext();//Advance original-chain pointer
      while (orig_chain_ptr != nullptr)
      {  // Get next item from original chain
         ItemType next_item = orig_chain_ptr->getItem();
         // Create a new node containing the next item
         Node<ItemType>* new_node_ptr = new Node<ItemType>(next_item);
         // Link new node to end of new chain
         new_chain_ptr->setNext(new_node_ptr);
         // Advance pointer to new last node
         new_chain_ptr = new_chain_ptr->getNext();
         // Advance original-chain pointer
         orig_chain_ptr = orig_chain_ptr->getNext();
      }  // end while
      new_chain_ptr->setNext(nullptr);  // Flag end of chain
 }  // end if
}  // end copy constructor
```

Called when object is initialized with a copy of another object, e.g. `LinkedBag<string> my_bag = your_bag;`

Copy first node

Two traversing pointers One to new chain, one to original chain

while

Copy item from current node

Create new node with item

Connect new node to new chain

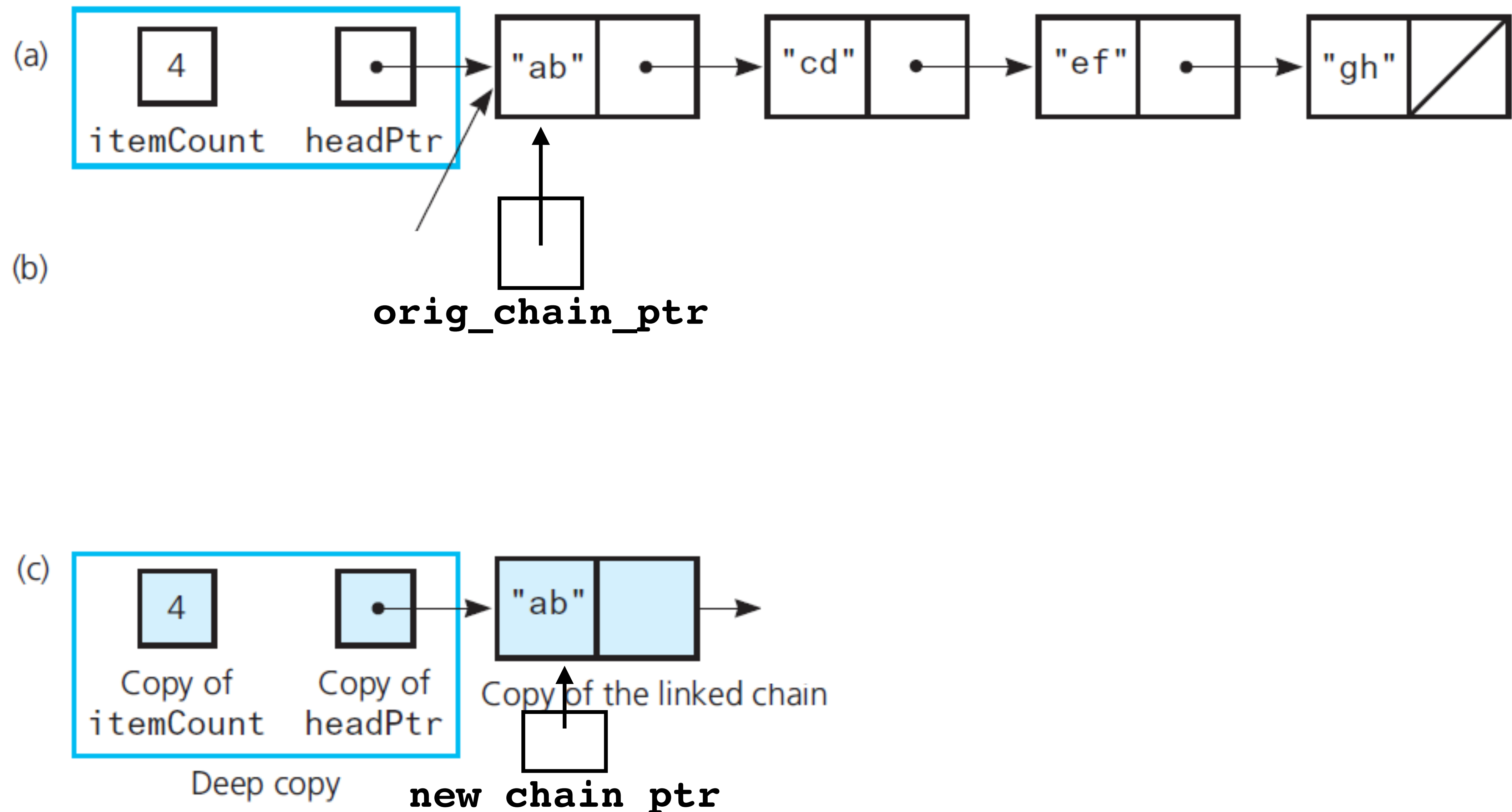
Advance pointer traversing new chain

Advance pointer traversing original chain

Signal last node

Deep vs Shallow Copy

```
// Copy first node
head_ptr_ = new Node<ItemType>();
head_ptr_->setItem(orig_chain_ptr->getItem());
// Copy remaining nodes
Node<ItemType>* new_chain_ptr = head_ptr_;
// Points to last node in new chain
orig_chain_ptr = orig_chain_ptr->getNext();
```



Deep vs Shallow Copy

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// Copy first node
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head_ptr_->setItem(orig_chain_ptr->getItem());
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Node<ItemType>* new_chain_ptr = head_ptr_;
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orig_chain_ptr = orig_chain_ptr->getNext();
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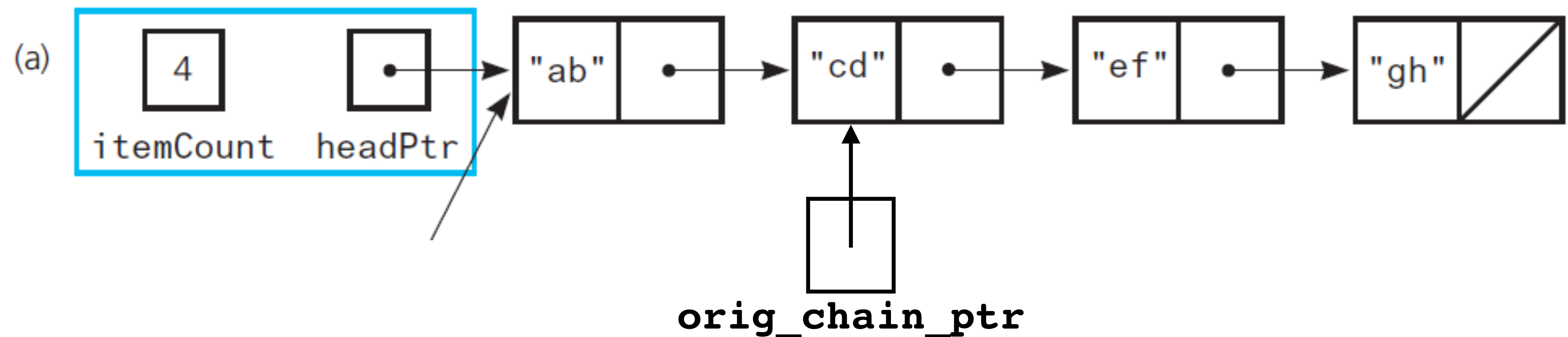
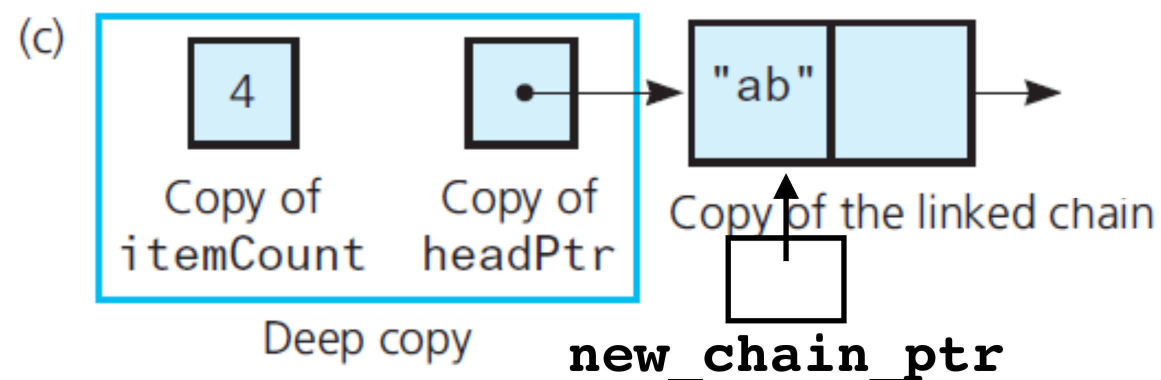
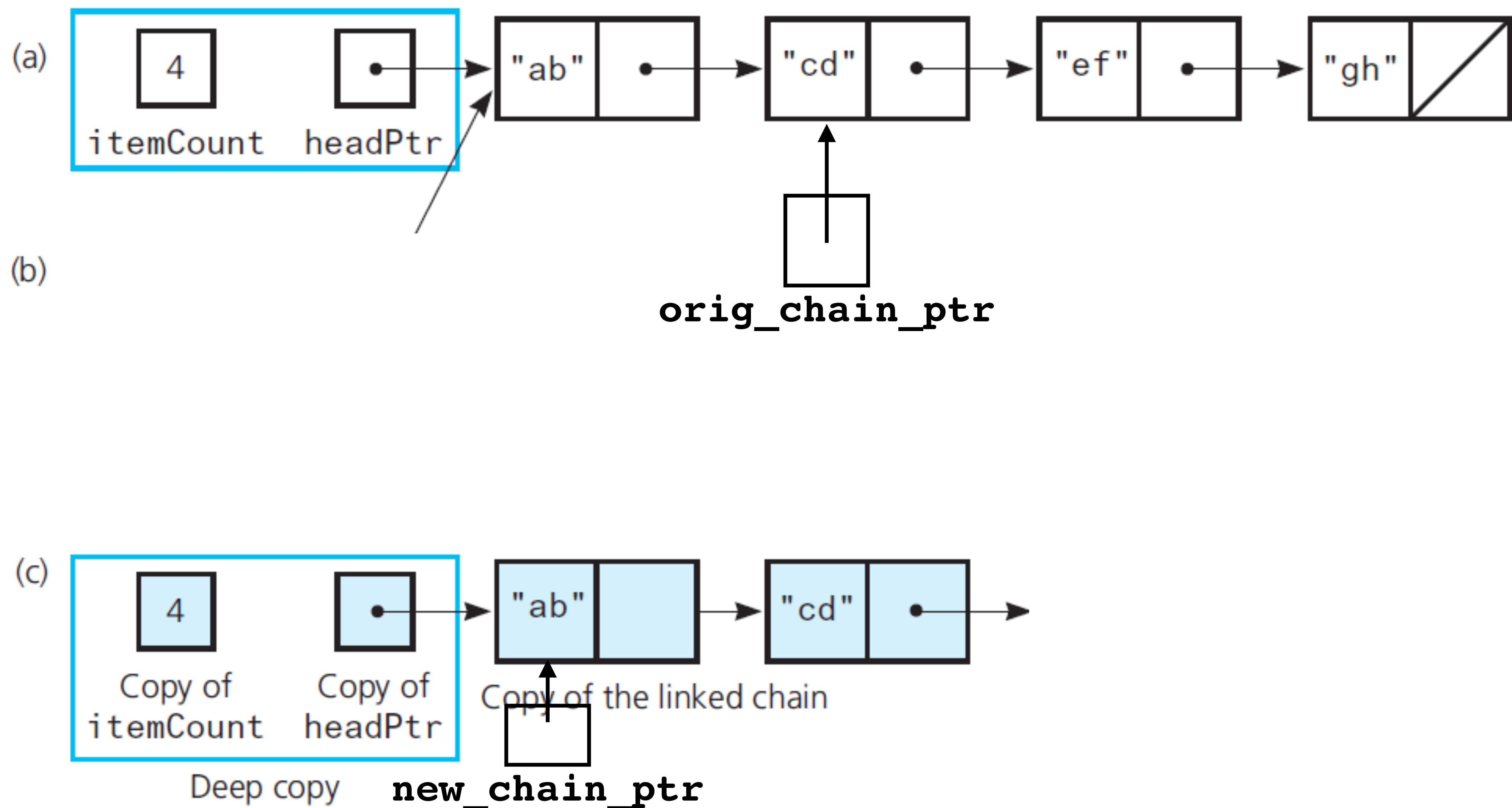




Deep vs Shallow Copy

```
while (orig_chain_ptr != nullptr) {
   // Get next item from original chain
   ItemType next_item = orig_chain_ptr->getItem();
   //Create a new node containing the next item
   Node<ItemType>* new_node_ptr = new Node<ItemType>(next_item);
   //Link new node to end of new chain
   new_chain_ptr->setNext(new_node_ptr);
   // Advance pointer to new last node
   new_chain_ptr = new_chain_ptr->getNext();
   / Advance original-chain pointer
   orig_chain_ptr = orig_chain_ptr->getNext();
}
```



Deep vs Shallow Copy

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while (orig_chain_ptr != nullptr) {
   // Get next item from original chain
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   //Link new node to end of new chain
   new_chain_ptr->setNext(new_node_ptr);
   // Advance pointer to new last node
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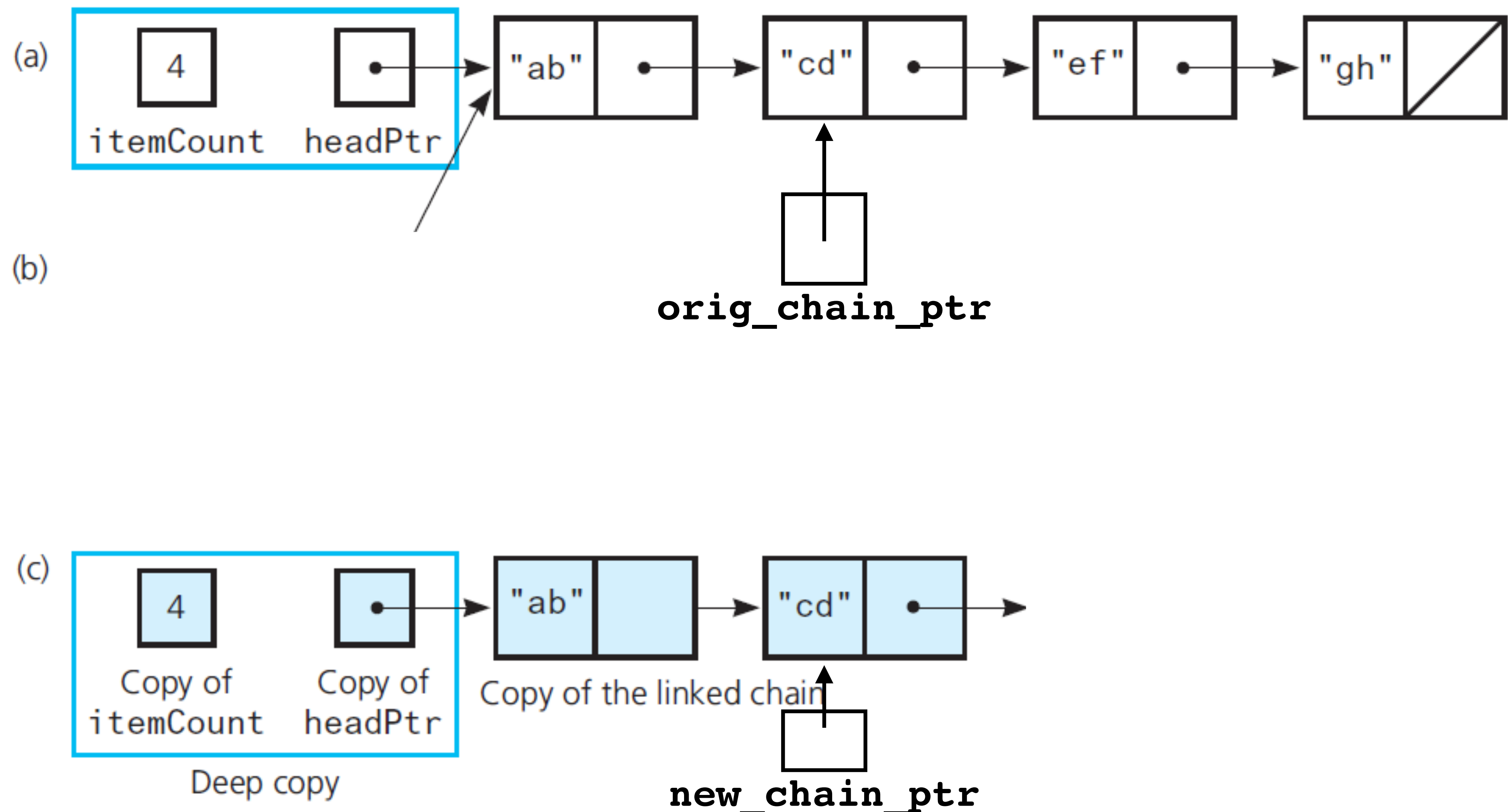
}
```



Deep vs Shallow Copy

```
while (orig_chain_ptr != nullptr) {
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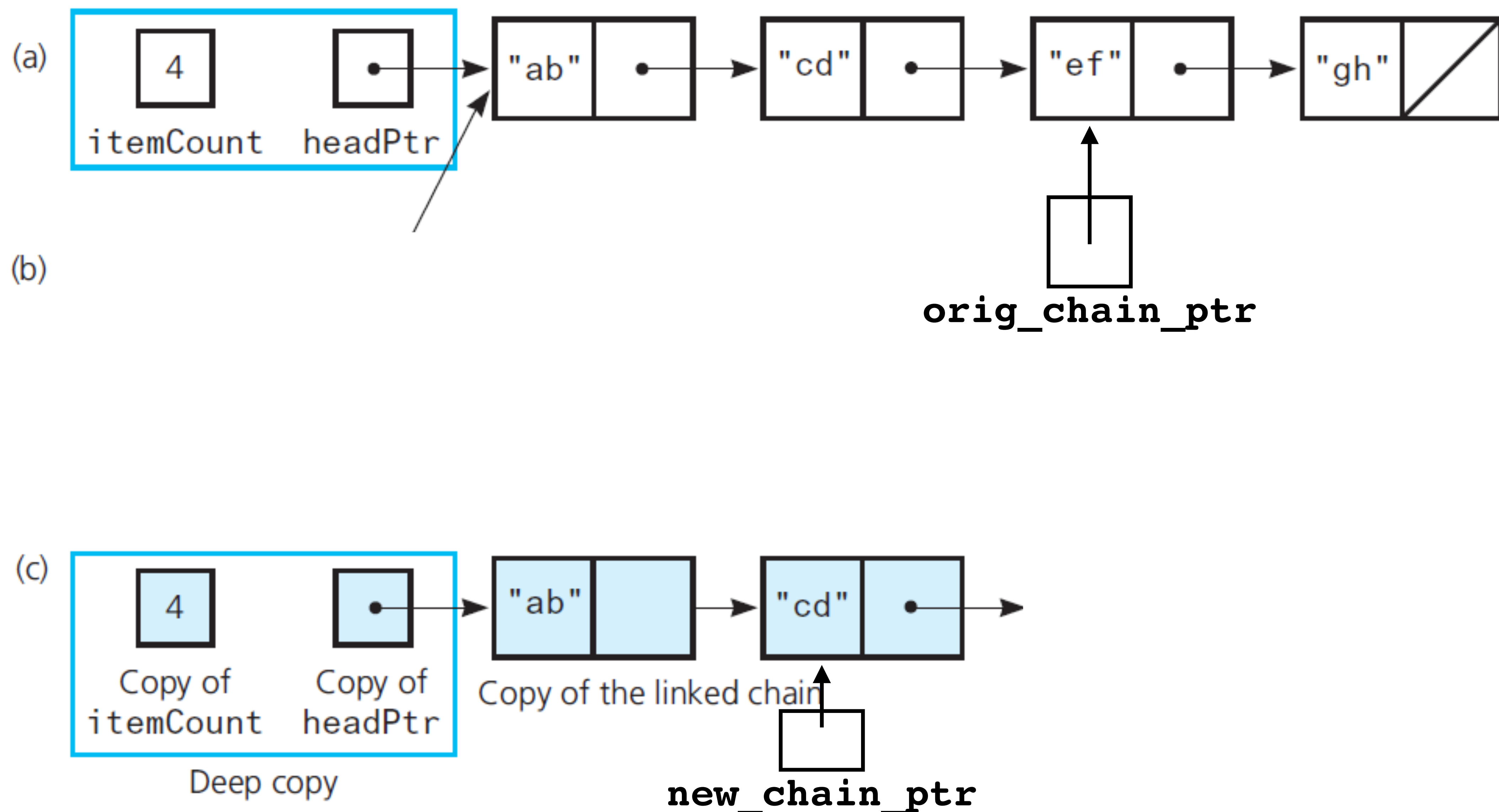
}
```



Deep vs Shallow Copy

```
while (orig_chain_ptr != nullptr) {
   // Get next item from original chain
   ItemType next_item = orig_chain_ptr->getItem();
   //Create a new node containing the next item
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   new_chain_ptr->setNext(new_node_ptr);
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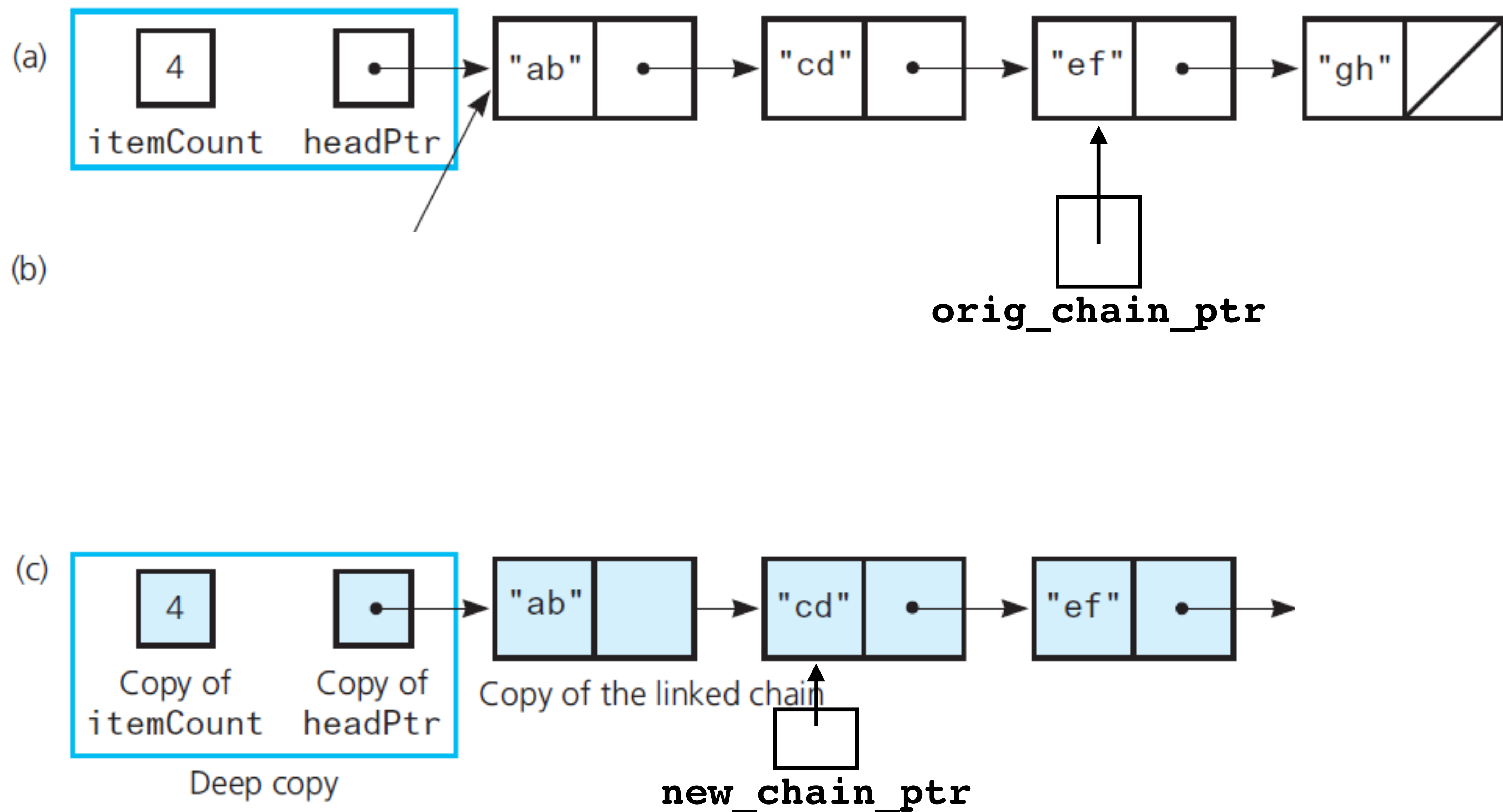
}
```



Deep vs Shallow Copy

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while (orig_chain_ptr != nullptr) {
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}
```
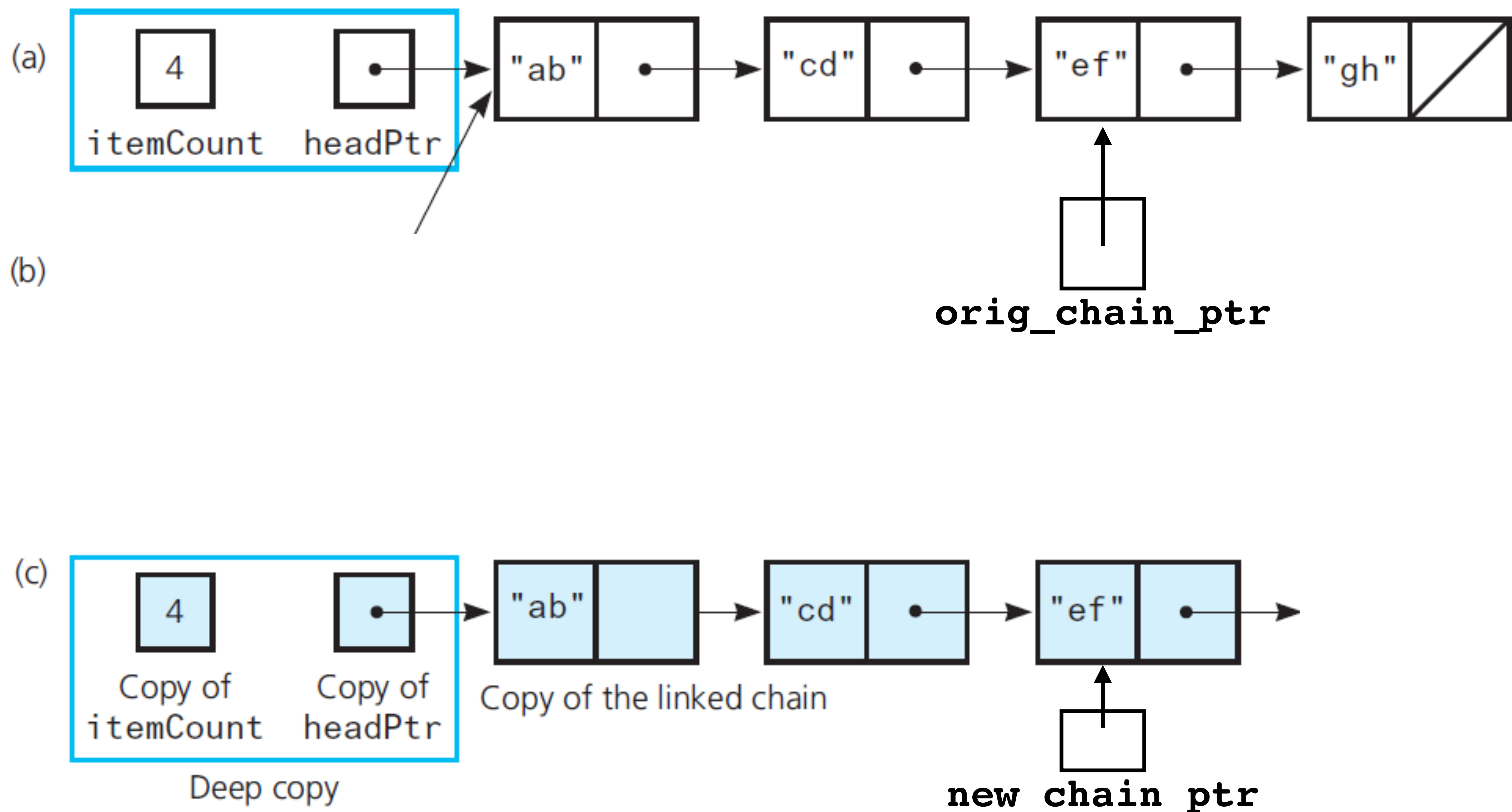
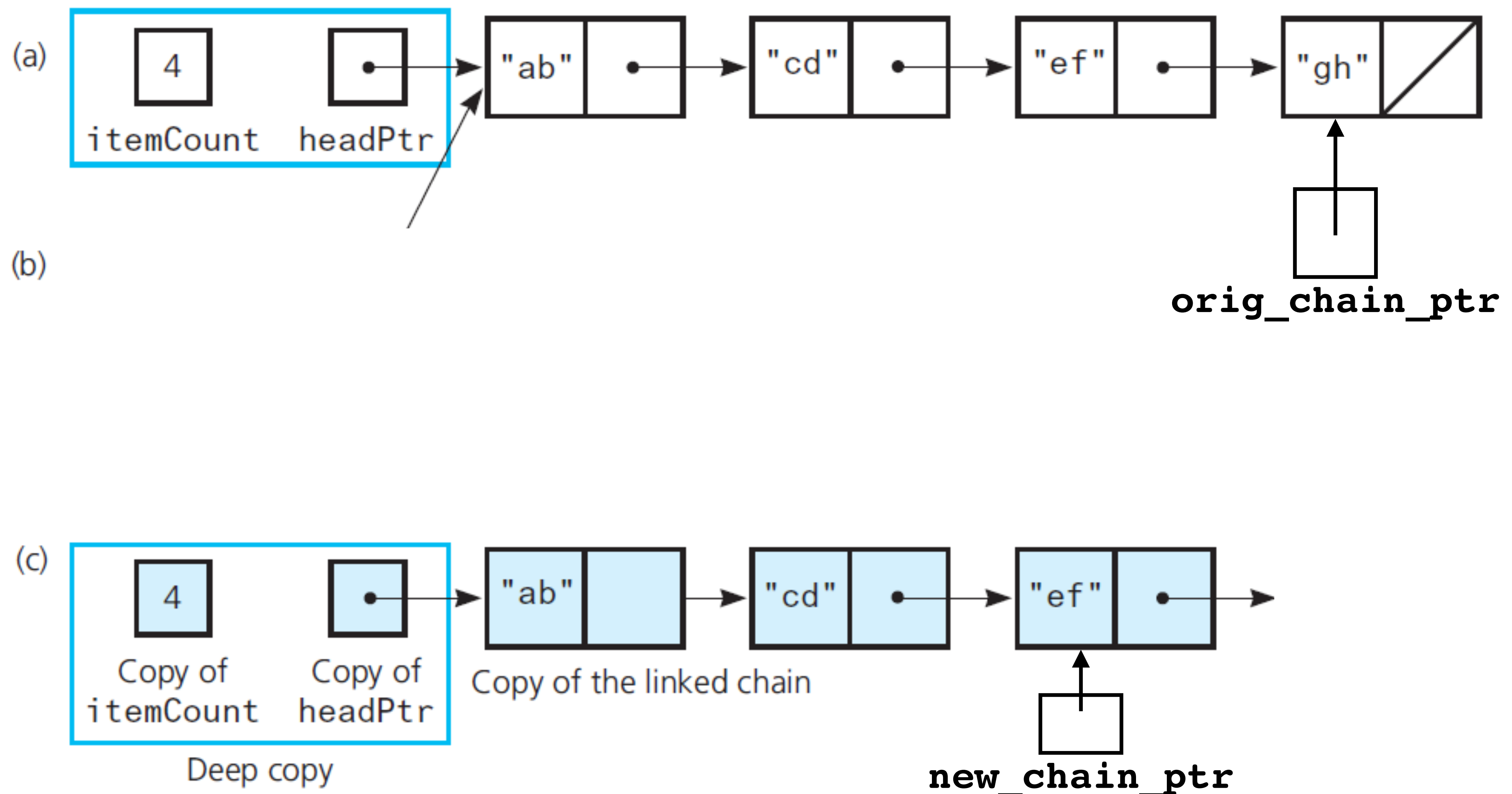



Deep vs Shallow Copy

```
while (orig_chain_ptr != nullptr) {
   // Get next item from original chain
   ItemType next_item = orig_chain_ptr->getItem();
   //Create a new node containing the next item
   Node<ItemType>* new_node_ptr = new Node<ItemType>(next_item);
   //Link new node to end of new chain
   new_chain_ptr->setNext(new_node_ptr);
   // Advance pointer to new last node
   new_chain_ptr = new_chain_ptr->getNext();
   / Advance original-chain pointer
   orig_chain_ptr = orig_chain_ptr->getNext();
}
```



Deep vs Shallow Copy

```
while (orig_chain_ptr != nullptr) {
   // Get next item from original chain
   ItemType next_item = orig_chain_ptr->getItem();
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   // Advance pointer to new last node
   new_chain_ptr = new_chain_ptr->getNext();
   / Advance original-chain pointer
   orig_chain_ptr = orig_chain_ptr->getNext();
}
```

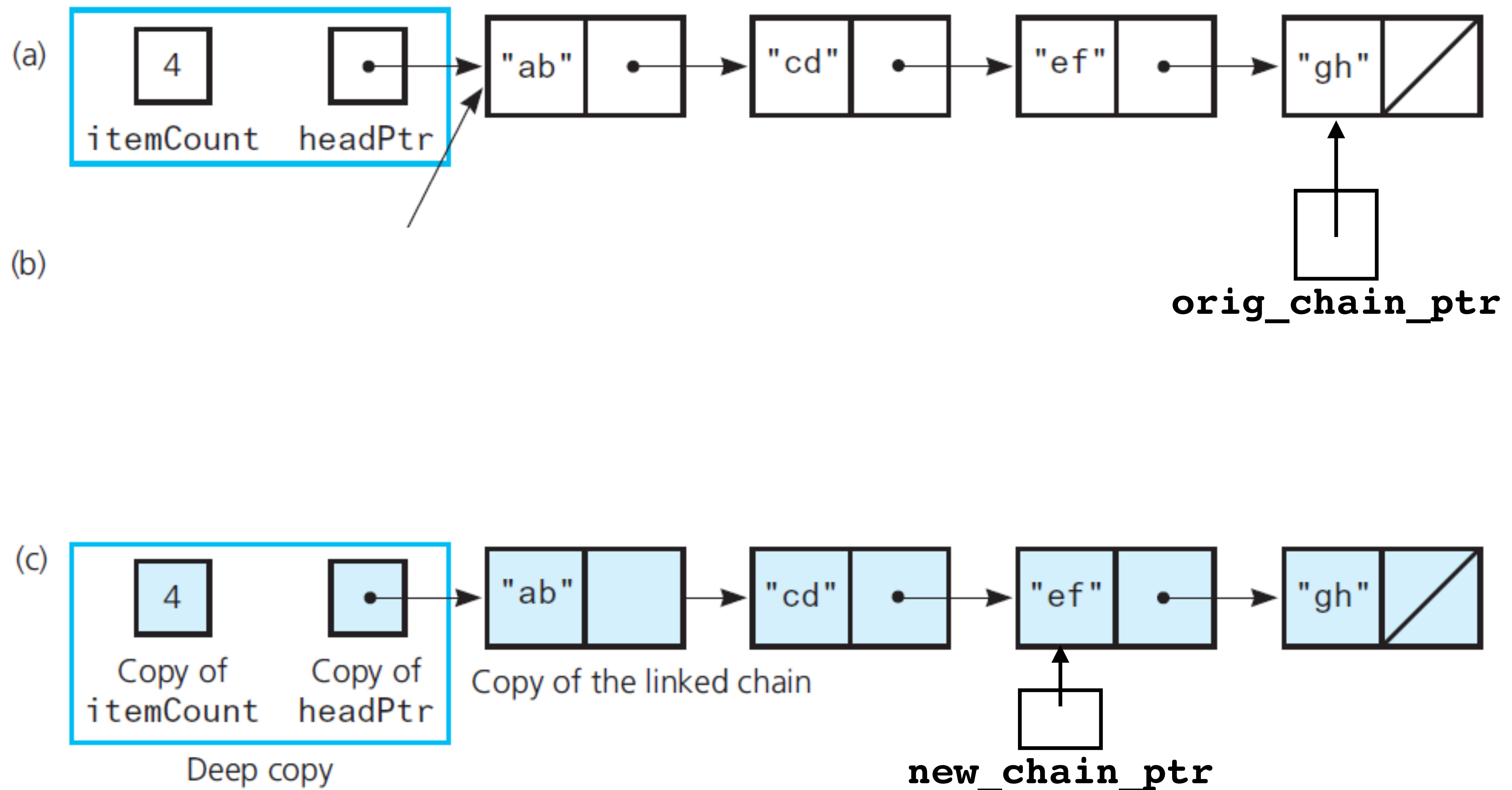

Deep vs Shallow Copy

```
while (orig_chain_ptr != nullptr) {
   // Get next item from original chain
   ItemType next_item = orig_chain_ptr->getItem();
   //Create a new node containing the next item
   Node<ItemType>* new_node_ptr = new Node<ItemType>(next_item);
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   / Advance original-chain pointer
   orig_chain_ptr = orig_chain_ptr->getNext();
}
```
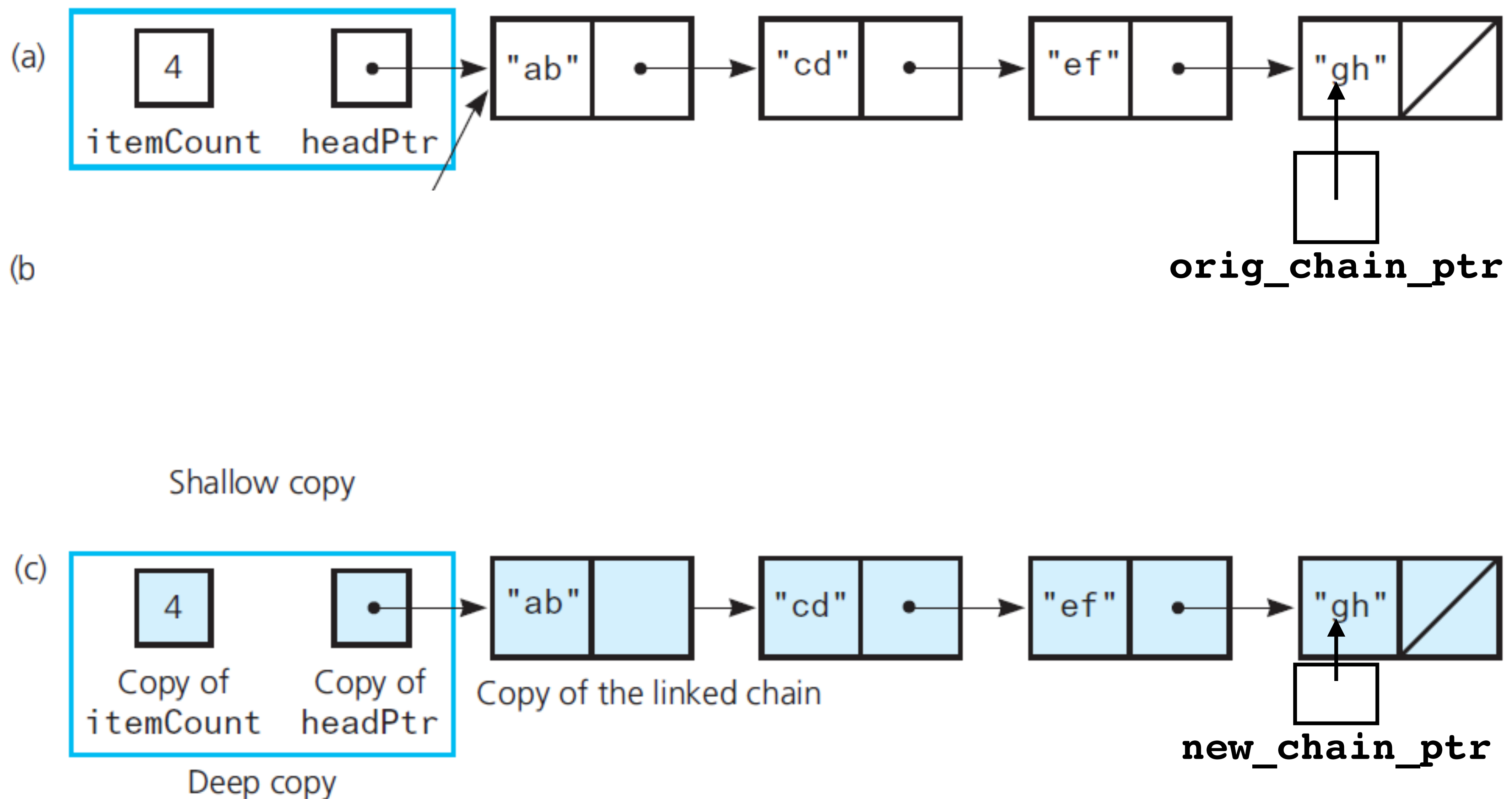



Efficiency Considerations

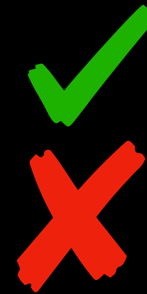
Every time you pass or return an object by value:
- Call copy constructor
- Call destructor

For linked chain:
- Traverse entire chain to copy (n *"steps"*)
- Traverse entire chain to destroy (n *"steps"*)

Preferred:

```
myFunction(const MyClass& object);
```

The Class LinkedBag




```
#ifndef LINKED_BAG_H_
#define LINKED_BAG_H_

#include "BagInterface.hpp"
#include "Node.hpp"

template<typename ItemType>
class LinkedBag
{
public:
 ✓LinkedBag();
 ✗LinkedBag(const LinkedBag<ItemType>& a_bag); // Copy constructor
 ✗~LinkedBag();                                // Destructor
 ✓int getCurrentSize() const;
 ✓bool isEmpty() const;
 ✓bool add(const ItemType& new_entry);
 ✗bool remove(const ItemType& an_entry);
 ✗void clear();
 ✗bool contains(const ItemType& an_entry) const;
 ✗int getFrequencyOf(const ItemType& an_entry) const;
 ✗std::vector<ItemType> toVector() const;

private:
   Node<ItemType>* head_ptr_; // Pointer to first node
   int item_count_;           // Current count of bag items

      // Returns either a pointer to the node containing a given entry
    // or the null pointer if the entry is not in the bag.
  ✗ Node<ItemType>* getPointerTo(const ItemType& target) const;
}; // end LinkedBag

#include "LinkedBag.cpp"
#endif //LINKED_BAG_H_
```