전산 SMP 12주차

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김범수

bskim45@gmail.com

Special thanks to 박기석 (kisuk0521@gmail.com)

기말고사 대비 총정리

기말고사 화이팅

자료구조

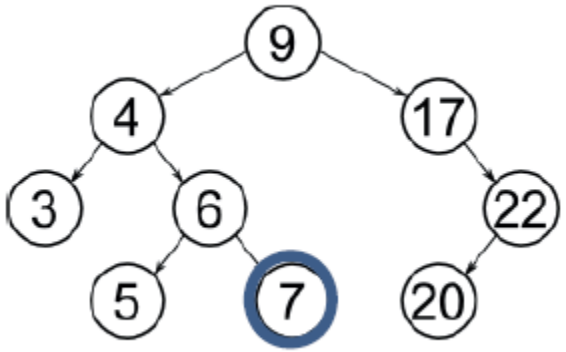
- 많은 데이터를 예쁘게 잘 저장해서
- 쉽고 빠르게 꺼내 쓰려고
- 데이터가 많아지면 찾는데도 오래 걸린다.

- Example: finding a number from a set of numbers
  - How many comparisons do we need to retrieve 7?

In linear array

8 comparisons

In binary search tree



4 comparisons

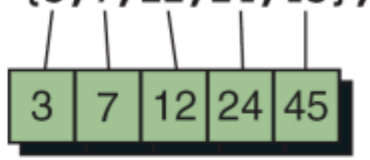
Array

(a) Basic Initialization

```
int numbers[5] = {3,7,12,24,45};
```

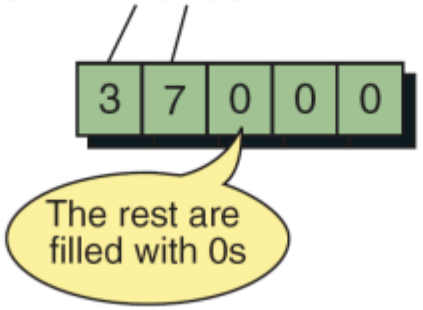
(b) Initialization without Size

```
int numbers[ ] = {3,7,12,24,45};
```



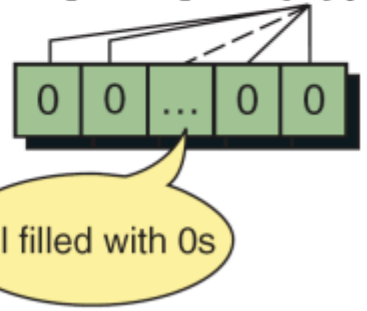
(c) Partial Initialization

```
int numbers[5] = {3,7};
```

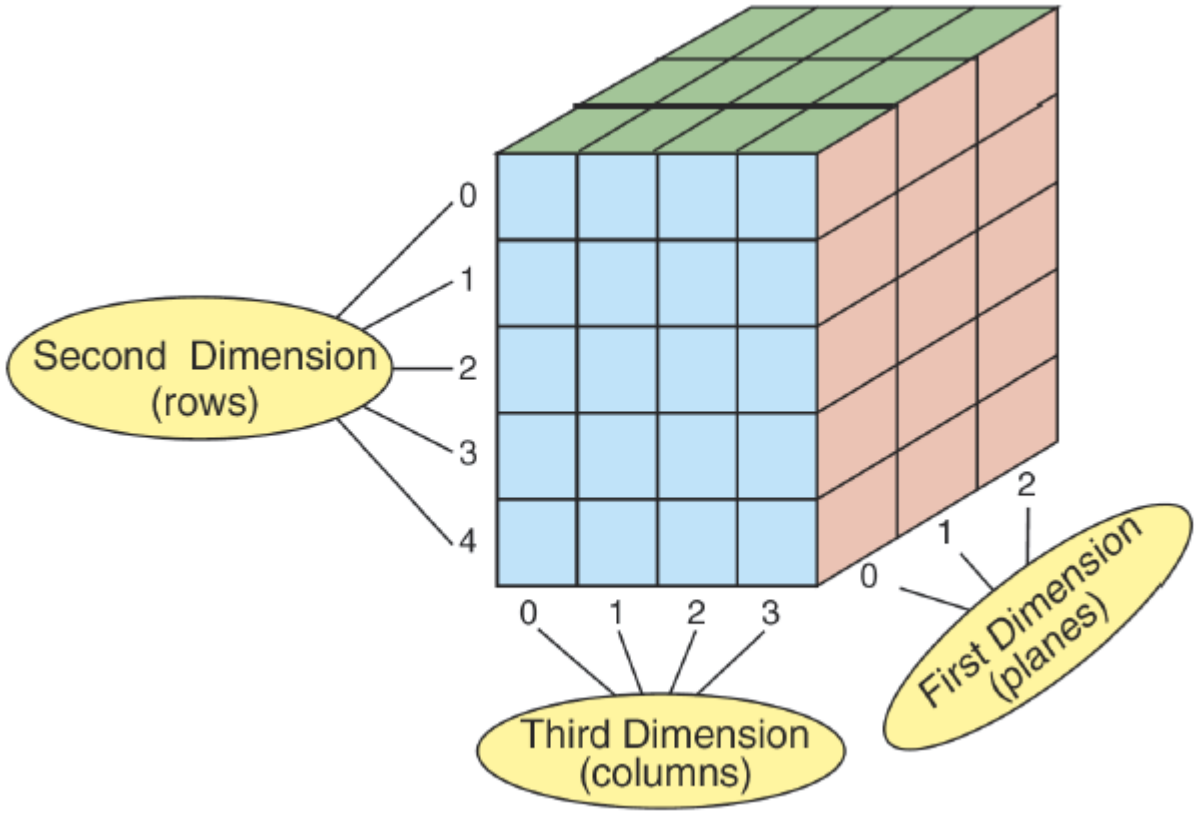


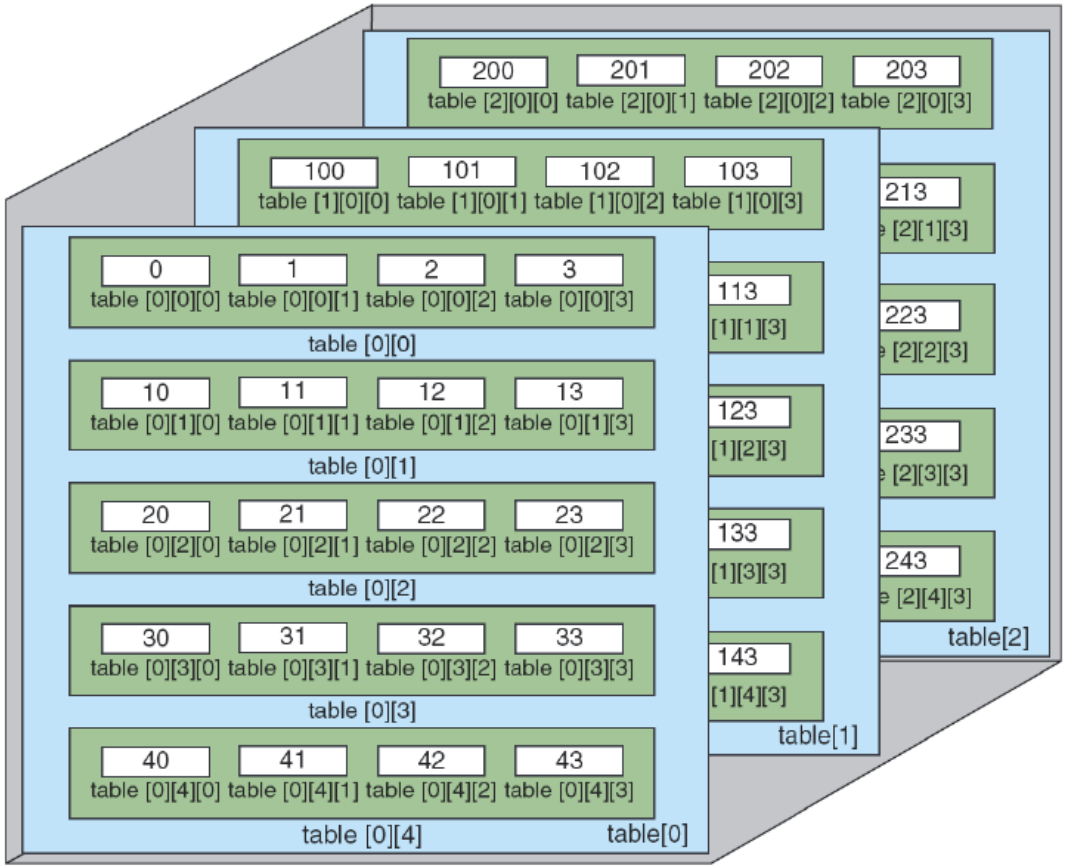
(d) Initialization to All Zeros

```
int lotsOfNumbers [1000] = {0};
```



Multi-dimension array



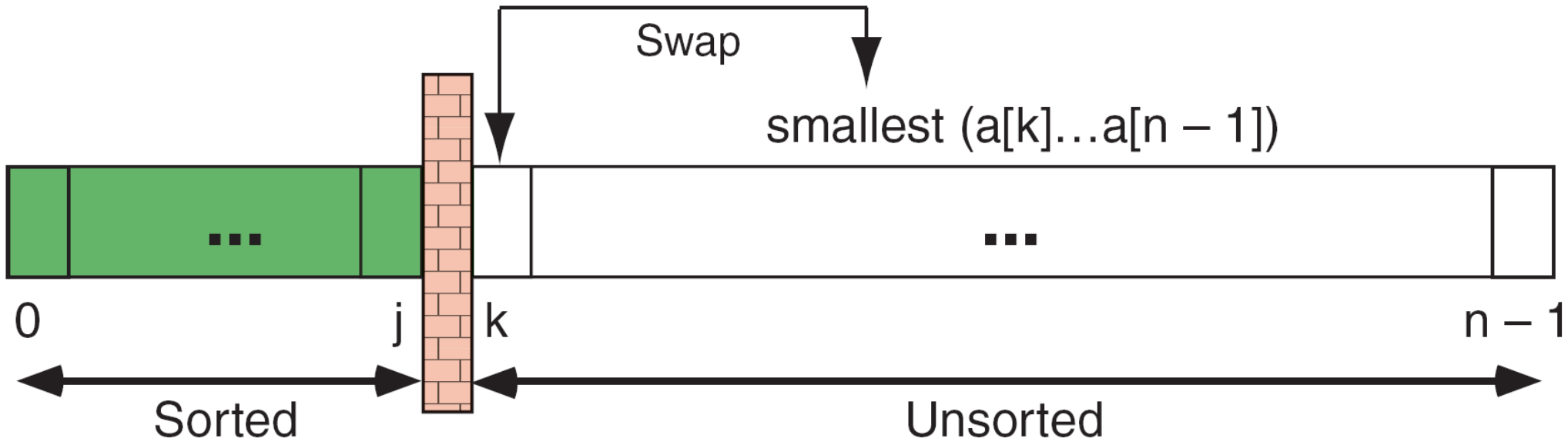


Sorting

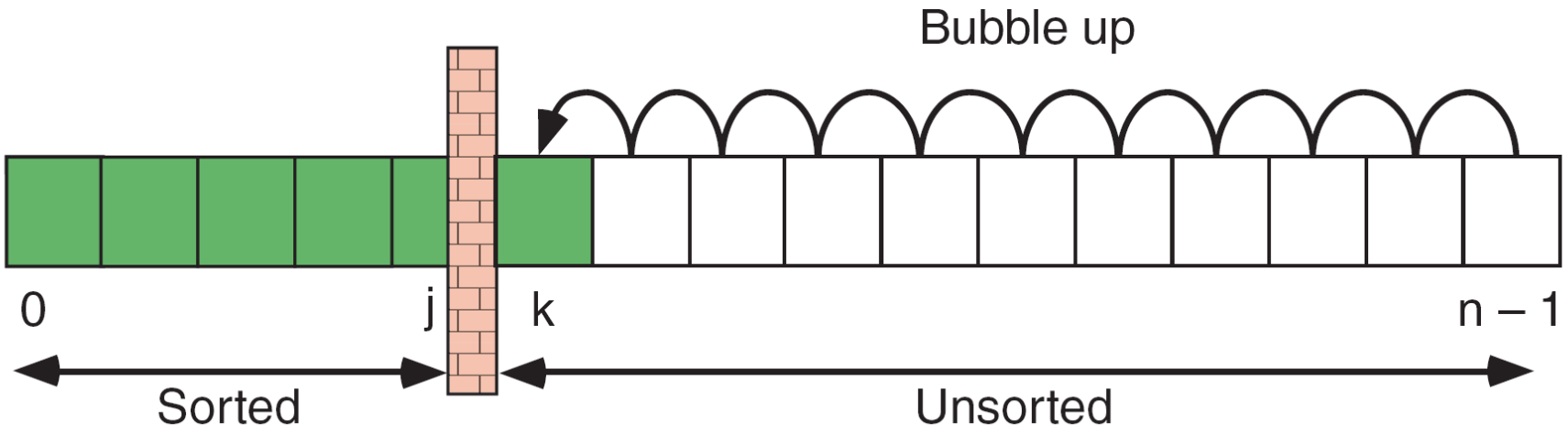
Array Sorting

- Selection Sort
- Bubble Sort
- Insertion Sort

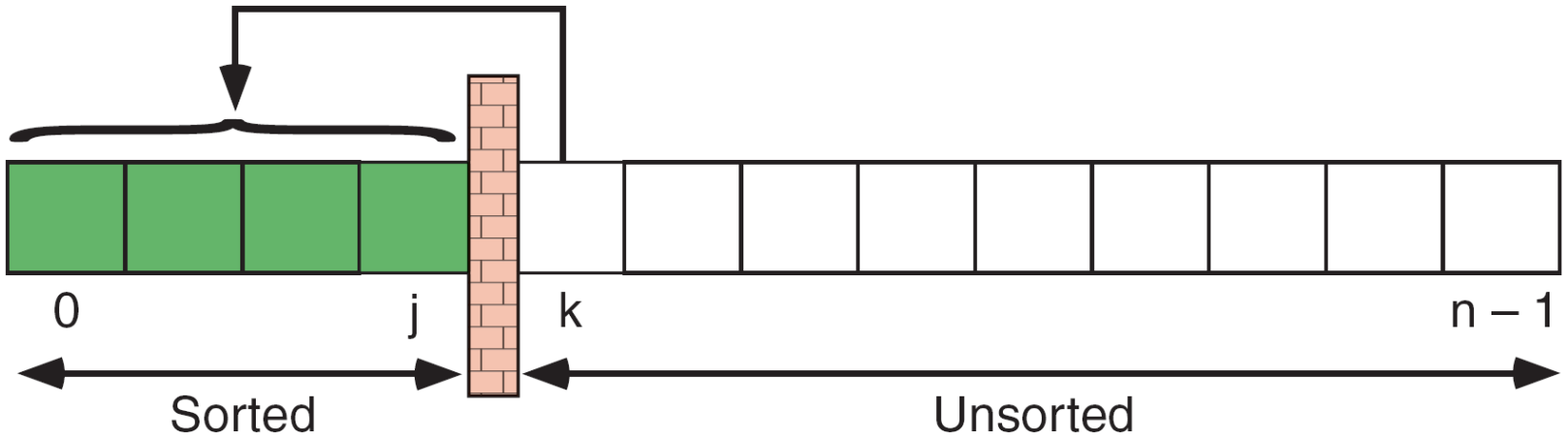
Selection Sort Concept



Bubble Sort Concept



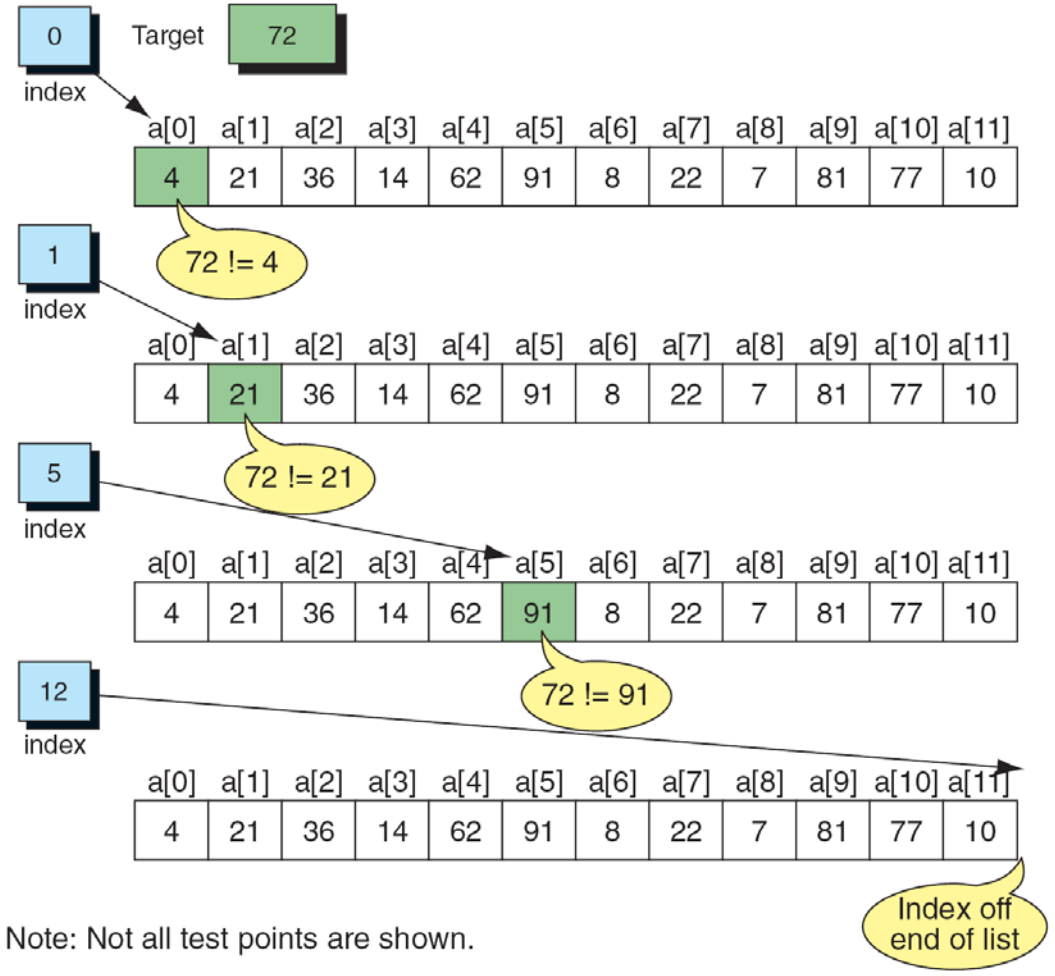
Insertion Sort Concept



Search

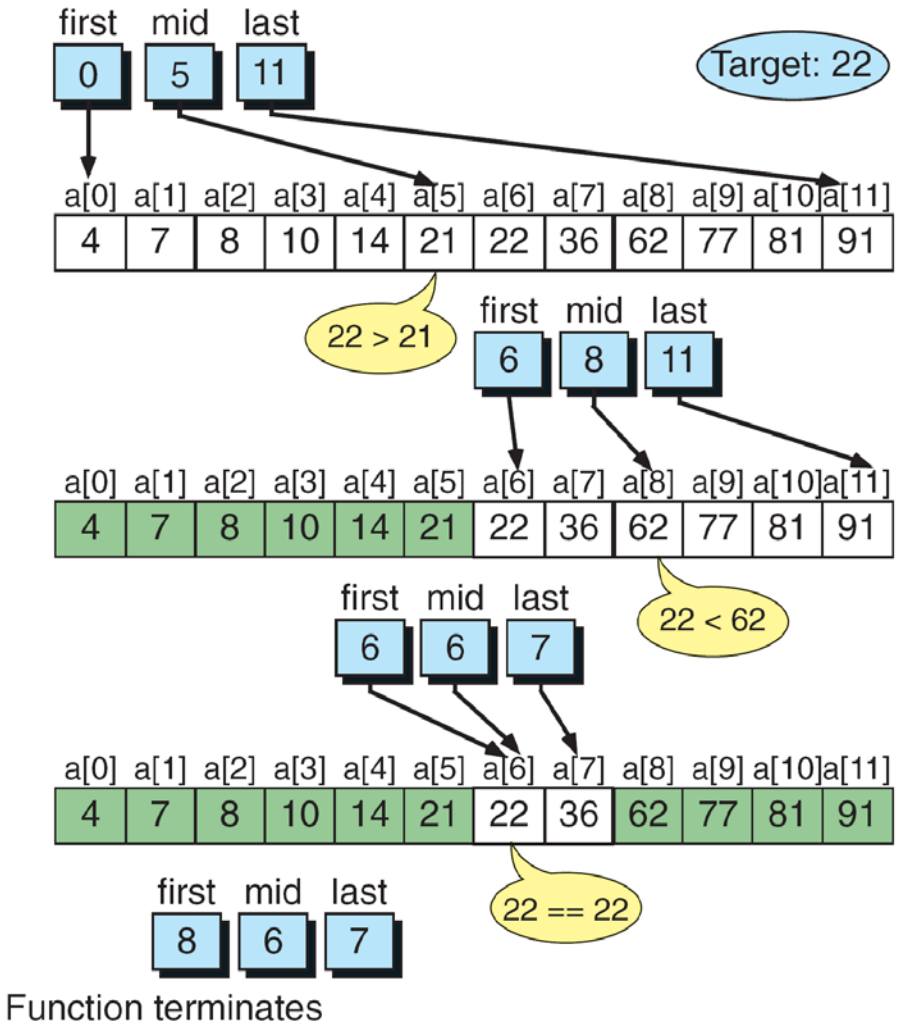
Sequential Search 특징

- Unsorted 배열에 대해서는 처음부터 쭉 봐야하기 때문에 비효율적이다.
- Worst Case: O(n)



Binary Search 특징

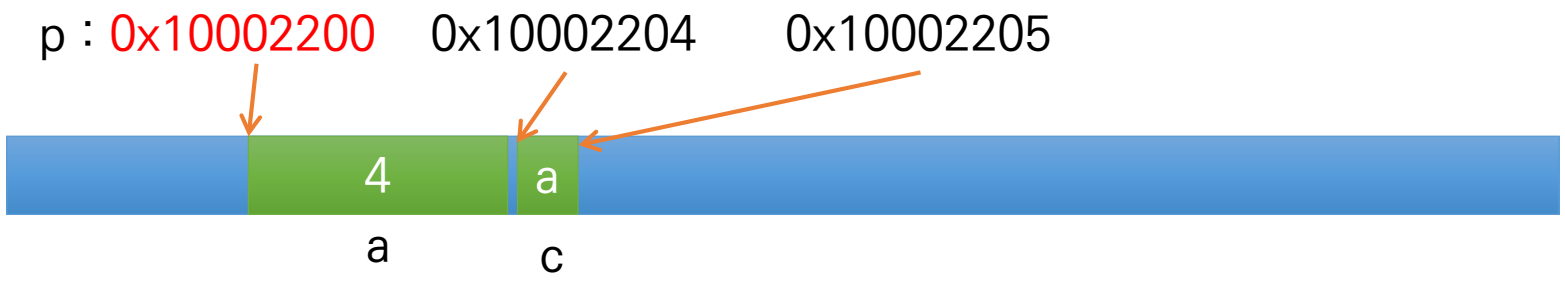
- 검색 대상 배열은 sorted 인 상태여야 한다.
  - “정렬된 데이터에 대해서는 이진검색이 빠르다”
- 매 iteration에서 반틈(1/2)을 서치 후보에서 제외시킨다.(제외된 거는 볼 필요 없음)
- O(logn)



Pointer

Pointer란?

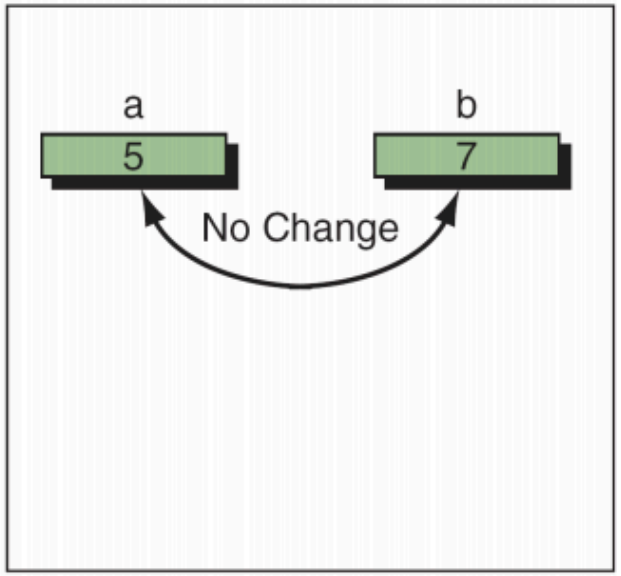
- 데이터 접근에 사용되는 주소를 저장하는 타입 – 포인터도 타입이다
- int a = 4; char c = ‘a’; int *p = &a;



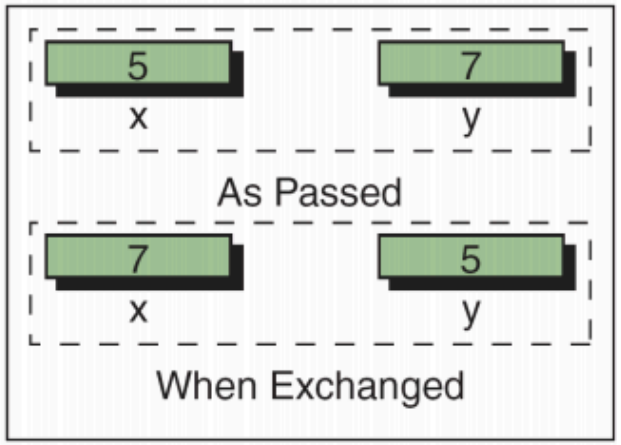
- 메모리는 긴 일차원 공간으로 볼 수 있고, 각 byte는 자신만의 주소를 가지고 있다.

Call-by-value

```
// Function Declarations
void exchange (int x, int y);

int main (void)
{
   int a = 5;
   int b = 7;
   exchange (a, b);
   printf("%d %d\n", a, b);
   return 0;
} // main
```



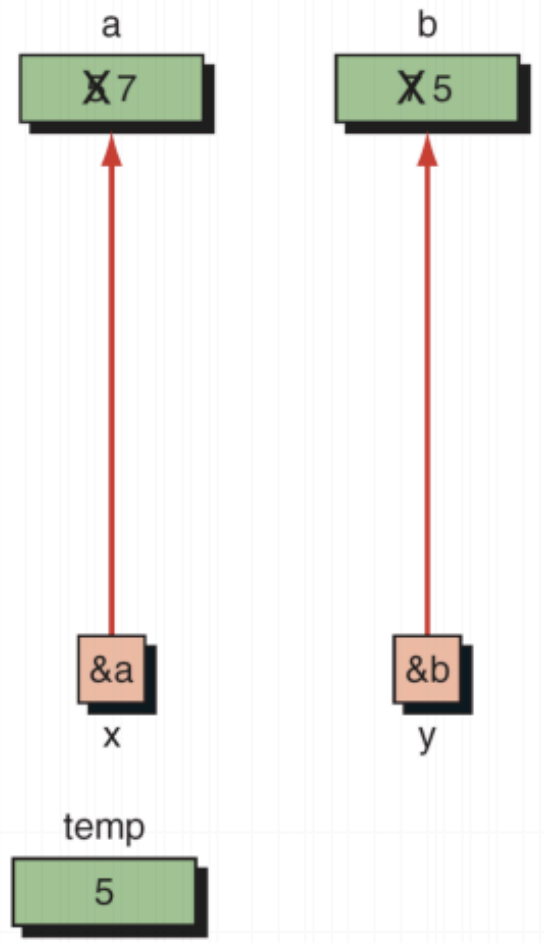

```
void exchange (int x, int y)
{
   int temp;

   temp = x;
   x    = y;
   y    = temp;
   return;
} // exchange
```



Call-by-reference

```
// Function Declaration
void exchange (int*, int*);

int main (void)
{
   int a = 5;
   int b = 7;

   exchange (&a, &b);
   printf("%d %d\n", a, b);
   return 0;
} // main
```

```
void exchange (int* px, int* py)
{
   int temp;

   temp = *px;
   *px  = *py;
   *py  = temp;
   return;
} // exchange
```



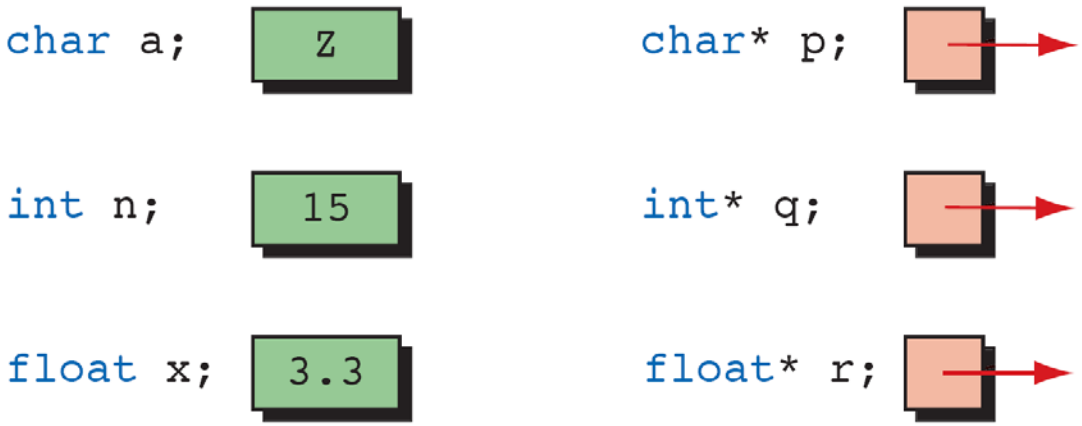
Pointer를 선언할 때 타입이 필요한 이유

int *p; char *q;

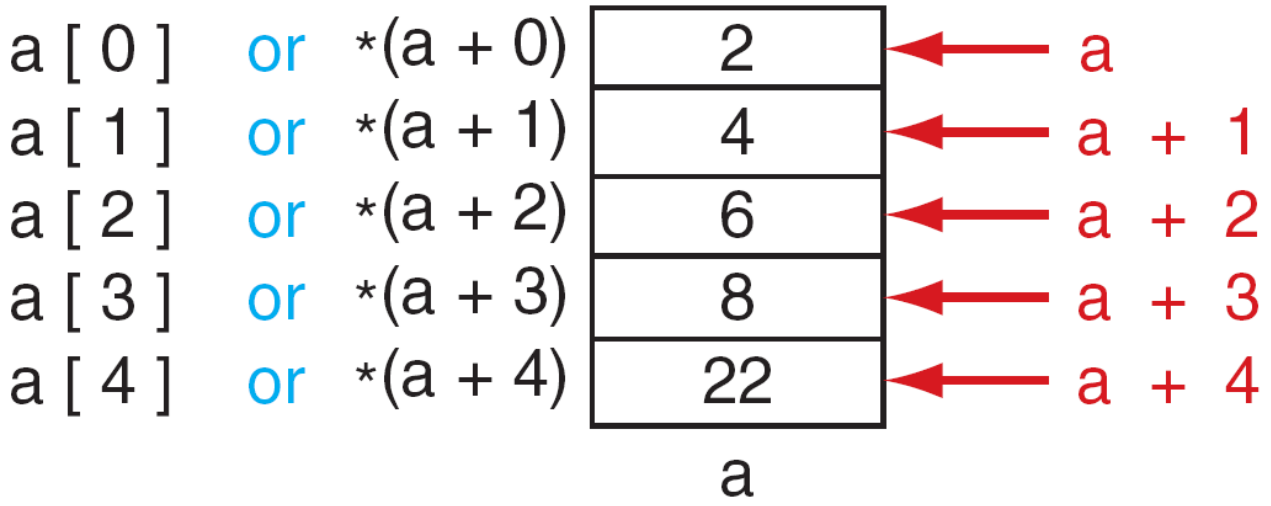
- 어차피 크기는 4byte(32 bit)로 다 똑같은 거 아닌가?
- 컴퓨터가 포인터로 메모리에 접근해 데이터를 읽어올 때!
  - 그 포인터 타입에 따라 가져오는 byte 수가 달라진다.

→“int * 포인터면 여기서 부터 4byte 까지 읽어서 정수로 쳐”

→“char * 포인터면 여기서 부터 1byte 만 읽어서 문자로 쳐”



배열 포인터 (Pointer to Arrays)



*(a + i) ⟺ a[i]

Dynamic Memory Allocation

동적할당

왜 쓰나요?

- 배열의 크기를 입력 받아 그 크기만큼의 배열을 만들고 싶을 때

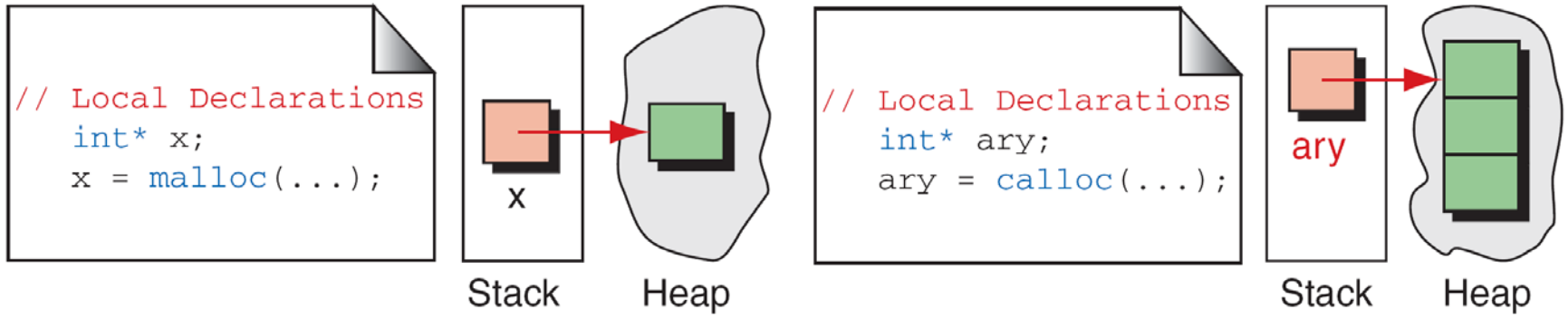
```
int main(void) {
    int size;

    scanf(“%d”, &size);

    int array[size];
}
```

Compile Error! 선언은 항상 맨 위에 와야 한다.
선언 후에 배열이 할당되어야 하는데… 이럴 때는 어떻게?

- 프로그램 실행 중에 메모리를 할당해 데이터를 저장할 공간을 생성하는 방법

Accessing Dynamic Memory

(a) Static Memory Allocation



(b) Dynamic Memory Allocation

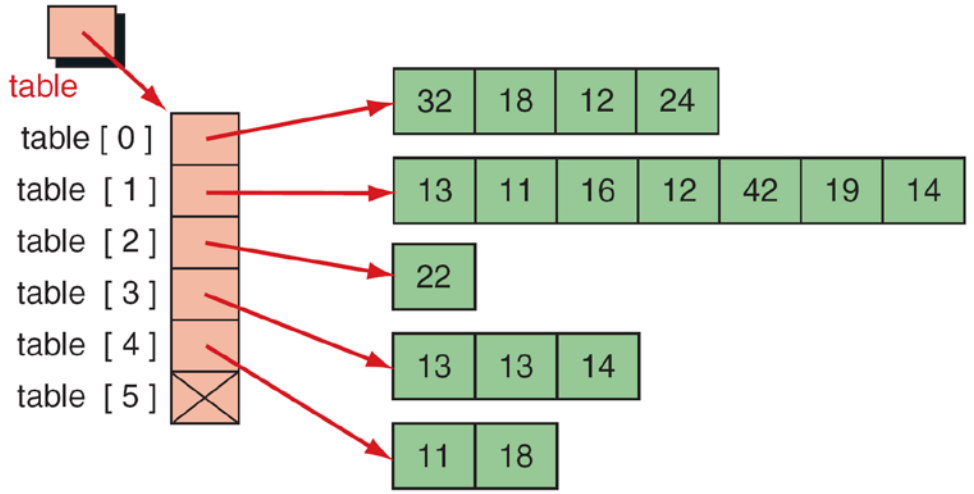
Dynamic Memory Allocation

- ⟨stdlib.h⟩

- void *malloc (size_t size);
- void *calloc (size_t element-count, size_t element-size);
- void *realloc (void* ptr, size_t newSize);
- void free (void* ptr);

동적할당으로 2차원 배열 만들기 – 포인터 배열

```
int **table;
table = (int **)calloc (3, sizeof(int *));
table[0] = (int *)calloc(4, sizeof(int));
...
...
...
```

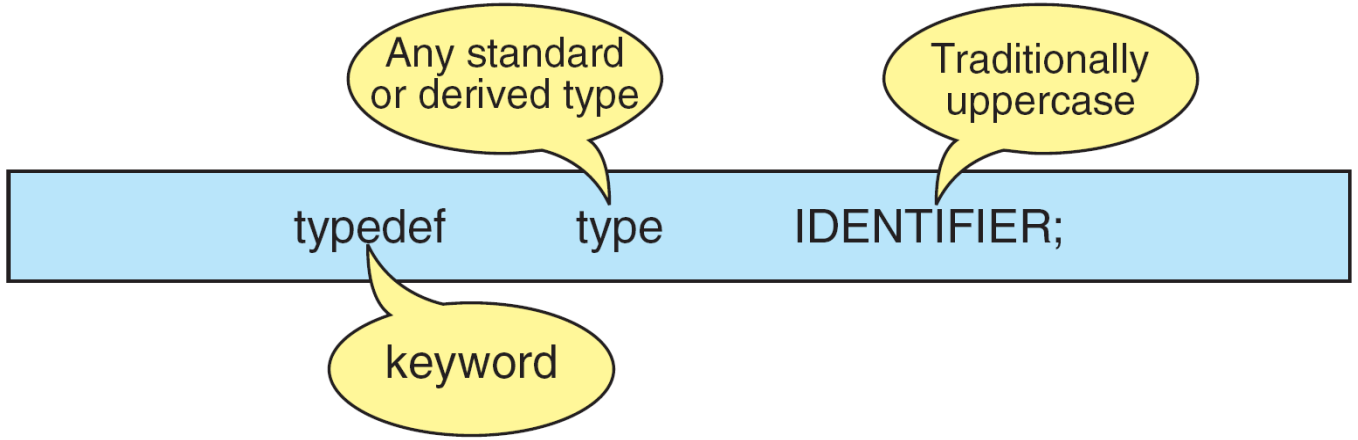



```
table = (int**)calloc (rowNum + 1, sizeof(int*));

table[0] = (int*)calloc (4, sizeof(int));
table[1] = (int*)calloc (7, sizeof(int));
table[2] = (int*)calloc (1, sizeof(int));
table[3] = (int*)calloc (3, sizeof(int));
table[4] = (int*)calloc (2, sizeof(int));
table[5] = NULL;
```

Structure

The Type Definition (typedef)

- A type definition, typedef, gives a name to a data type by creating a new type that can then be used anywhere a type is permitted.
- 프로그래머는 길게 쓰는 것을 싫어한다



typedef int INGETER;

Enumerate Type

- 항목 혹은 선택지, 일종의 상수 항목을 만들 때 사용
- 각 항목들에 대해 identifier로써 하나의 정수(enumeration constant)가 할당됨

- 상황) 메뉴를 만들고 숫자 하나 입력받아서 switch 문으로 각기 다른 함수를 실행해야 한다.
- 그냥 숫자 0, 1, 2, 3으로 나누면 나중에 헷갈리고 불편함

Initializing Enumerated Constants

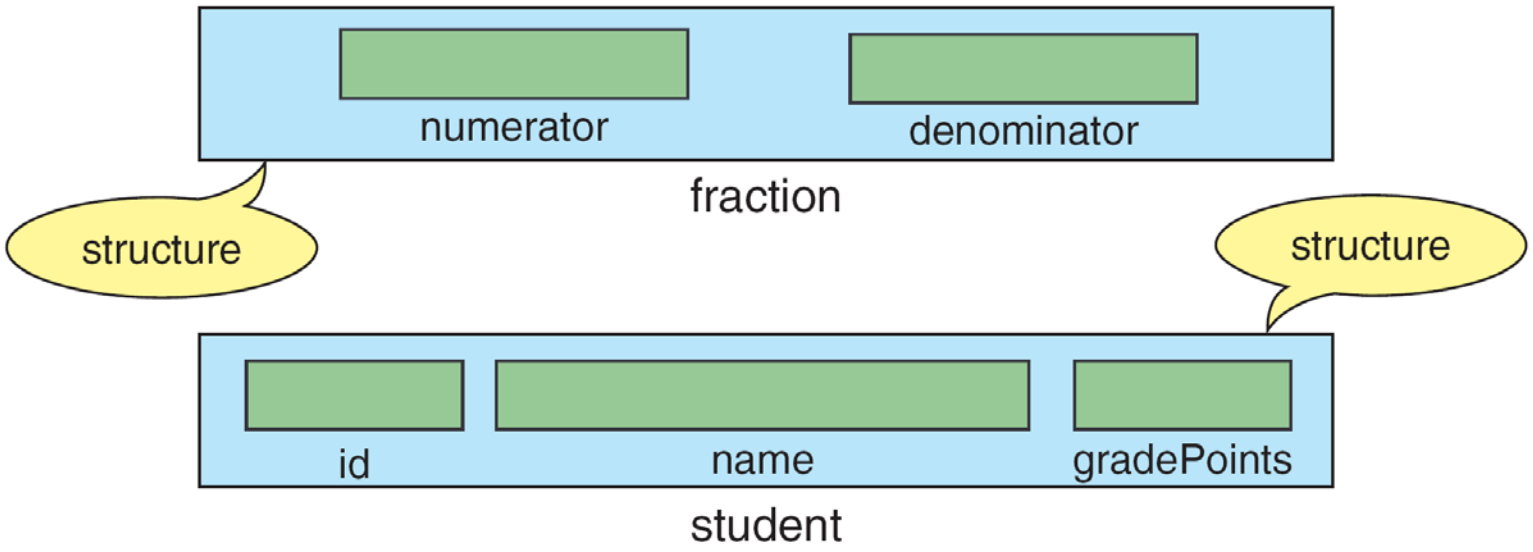
- enum months {JAN, FEB, MAR, APR};

  identifier 자동 배정 0 1 2 3

- enum months {JAN = 1, FEB, MAR, APR};
- enum color {RED, ROSE = 0, CRIMSON = 0, BLUE, AQUA = 1};

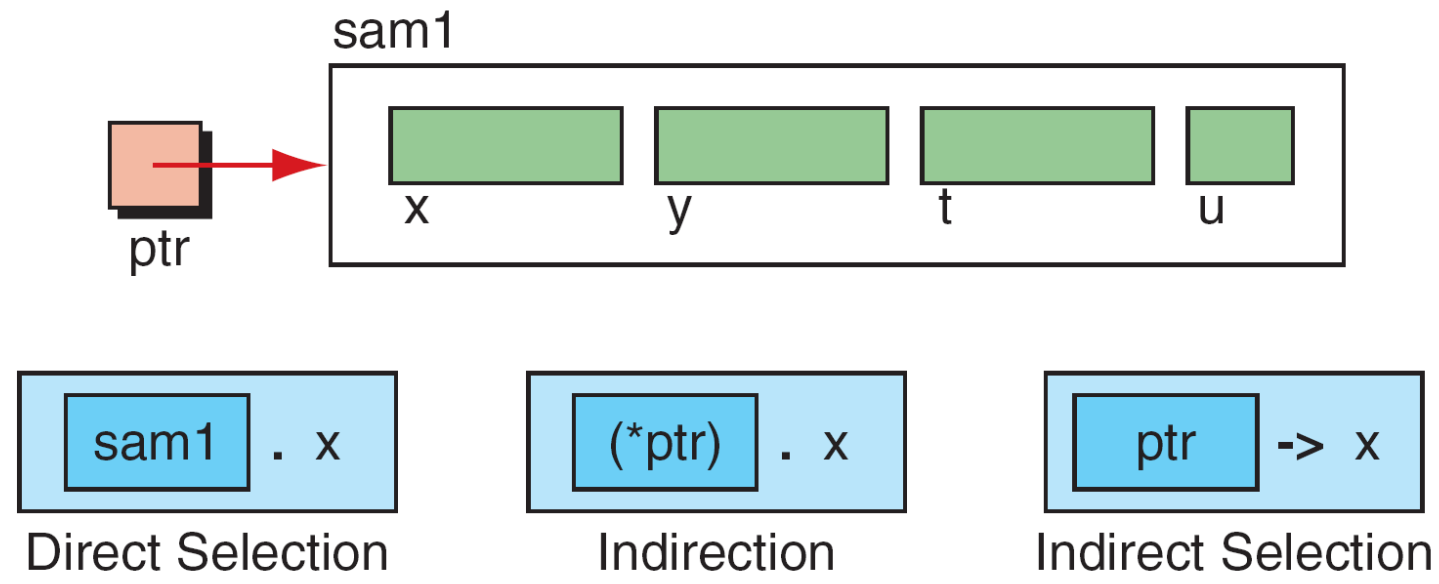
Structure Type

- 관련되는 element 들의 집합.
- 어떤 타입의 변수라도 올 수 있다.
- 단, 함수는 구조체의 element로 안 된다. 오직 변수만 가능



Accessing Structure Elements

```
typedef struct
  {
   int    x;
   int    y;
   float  t;
   char   u;
  } SAMPLE;
  …
  SAMPLE  sam1;
  SAMPLE* ptr;
  …
  ptr = &sam1;
  …
```



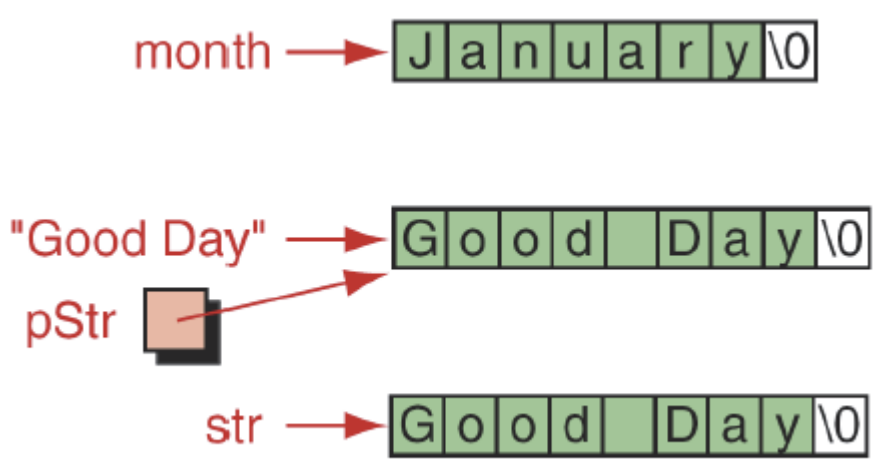
Three Ways to Reference the Field **x**

(*pointerName).fieldname ⟺ pointerName->fieldName.

String

문자열의 선언

- char str[15] = “Good Day”;
  - 할당한 용량을 모두 사용할 필요는 없습니다.
- char month[] = “January”;
  - 배열크기가 문자열의 길이에 맞춰 자동으로 설정
- char *pStr = “Good Day”;
- char str[9] = {‘G’, ‘o’, ‘o’, ‘d’, ‘ ‘, ‘D’, ‘a’, ‘y’, ‘\0’};

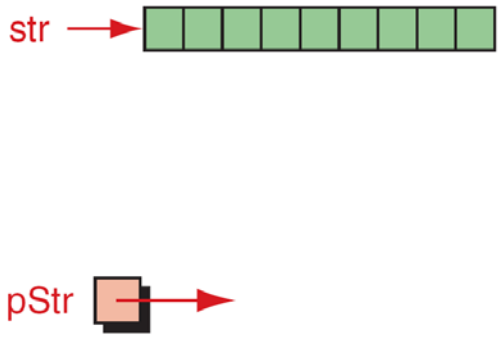



```
// Local Declarations
   char str[9];
```

(a) String Declaration

```
// Local Declarations
   char* pStr;
```

(b) String Pointer Declaration



String Copy?

- char str1[6] = “Hello”;
  char str2[6];
  str2 = str1; // ?

String Input/Output Functions

formatted input/output functions

- scanf/fscanf
- printf/fprintf

special set of string-only functions

- get string (gets/fgets)
- put string (puts/fputs).

FLUSH

- 스트림 버퍼를 비우는 역할을 한다.
- Scanf 등 입력받는 함수 사용 시

→ The string conversion code(s) skips whitespace.

Test)
int a; char b;
scanf(“%d”, &a);
scanf(“%c”,&b);
printf(“%d %c\n”, a, b);

fflush();
#define FLUSH while(getchar != ‘\n’)

```
1  {  // Read Month
2     #define FLUSH while (getchar() != '\n')
3     char month[10];
4
5     printf("Please enter a month. ");
6     scanf("%9s", month);
7     FLUSH;
8  }  // Read Month
```

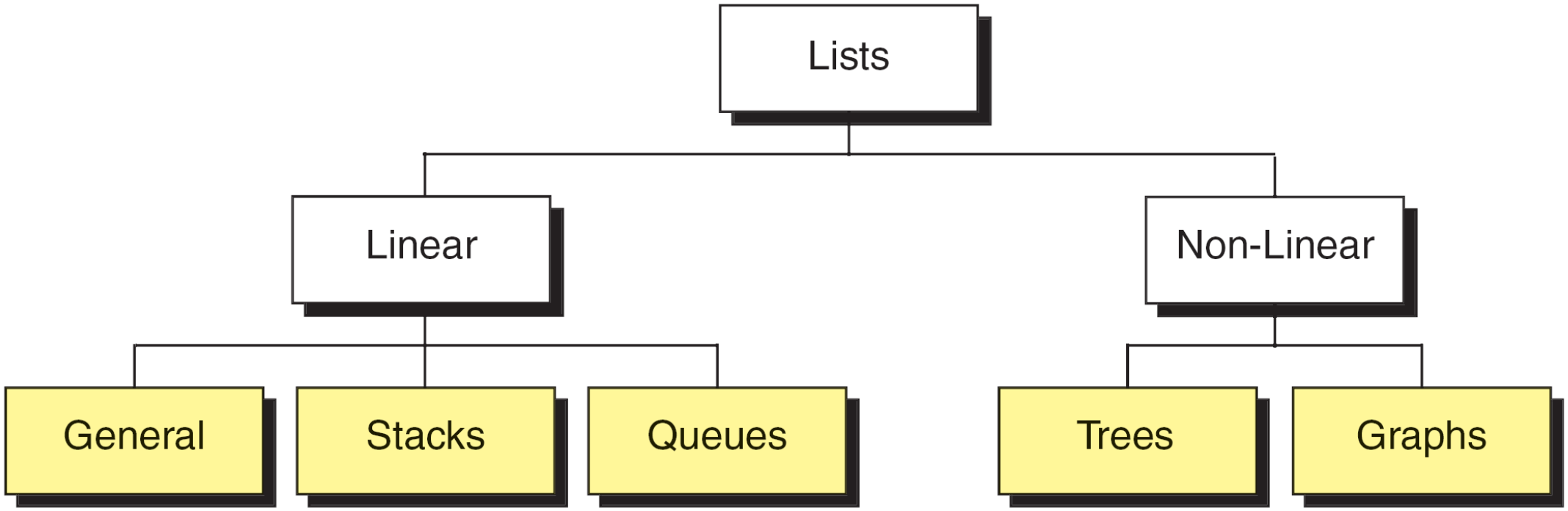
String Manipulation Functions

- #include ⟨string.h⟩

- String Length and String Copy
- String Compare and String Concatenate
- Character in String
- Search for a Substring and Search for Character in Set
- String Span and String Token
- String to Number

List

What to learn…



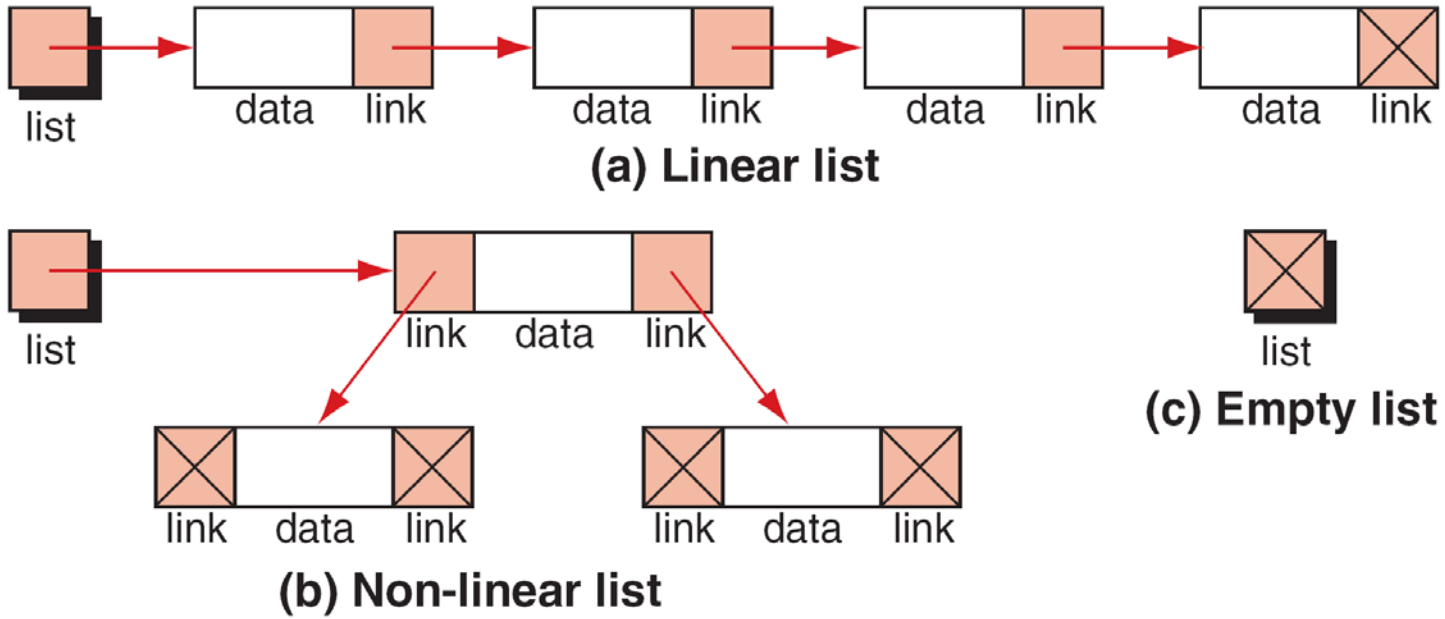
Linked List

- 각각의 Element가 다음 Element의 위치를 저장하여 이어진 데이터 스트럭쳐
- 연속으로 쭉 이어졌다면 왜 배열(Array)를 안쓸까??
  - Array의 장점? 단점?
- Linked List의 장점? 단점?

	List	Linked List
Space Complexity	O(n)	
At	O(1)	O(n)
Insert	O(n)	O(1)
Remove	O(n)	O(1)

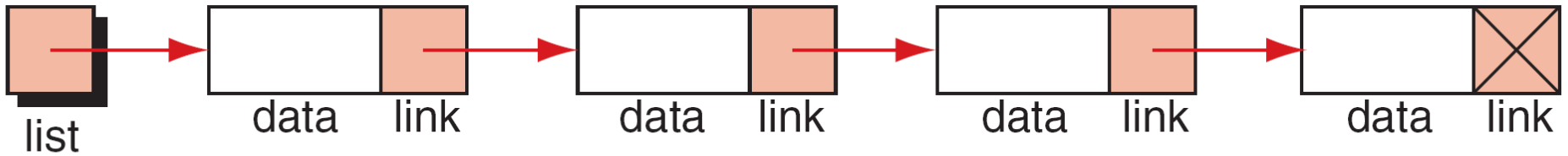
Linked List

- 한개만 가리킬 수도 있고, 여러개를 가리킬 수도 있고…



General Linear Lists

- 가장 일반적인 직렬 리스트
  - Retrieve
  - Insert
  - Change
  - Delete
  - Traversing
  - Building



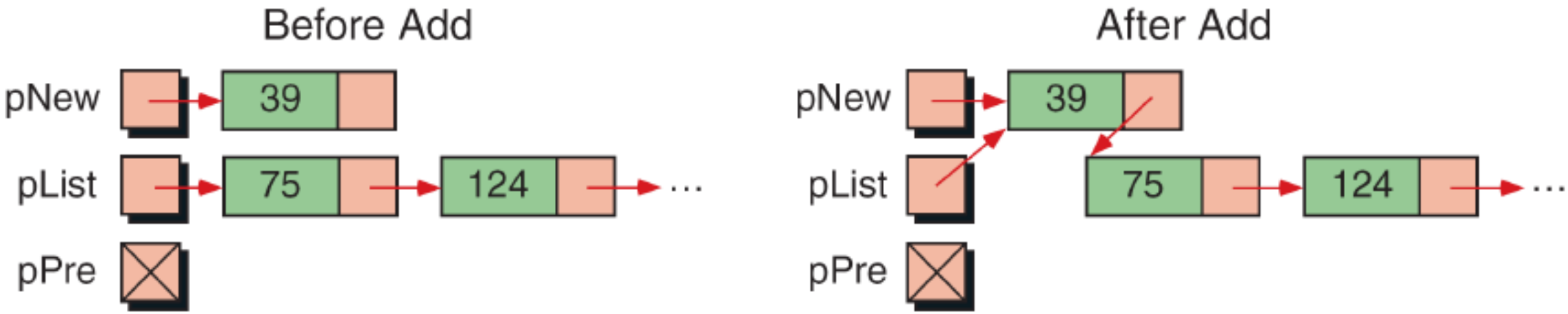
(a) Linear list

Insert a Node to Empty List

```
pNew->link  =  pList ;
pList       =  pNew ;
```

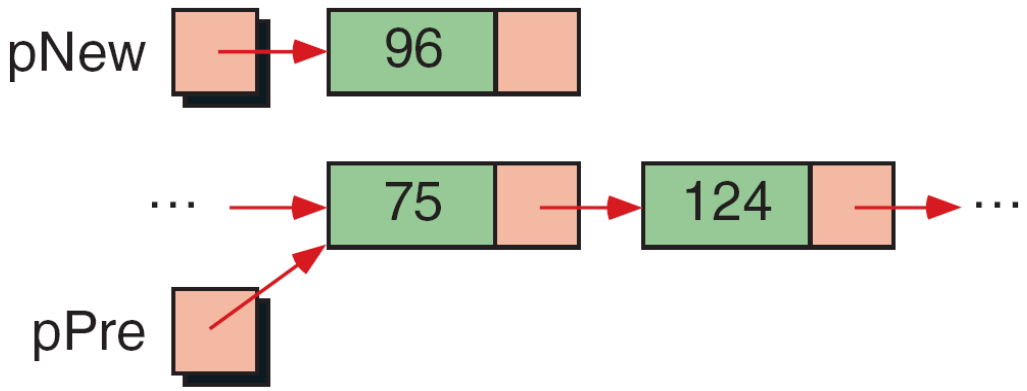
Insert a Node at Beginning

```
pNew->link  =  pList ;
pList       =  pNew;
```

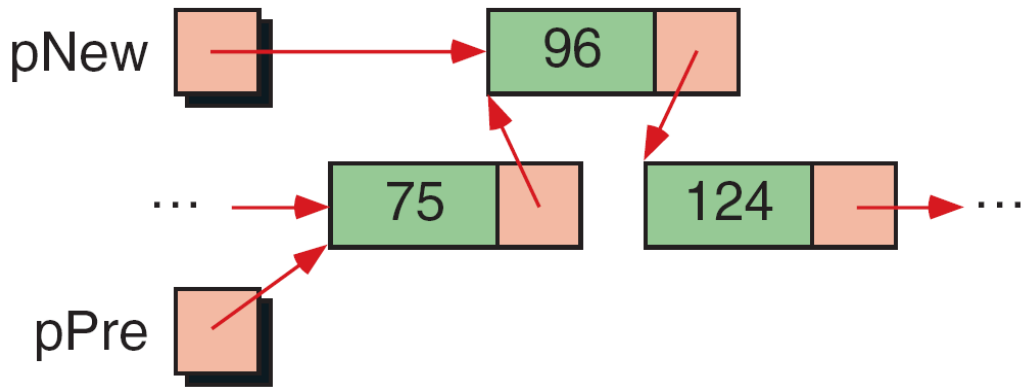


Insert a Node in Middle

```
pNew->link = pPre–>link;
pPre->link = pNew;
```



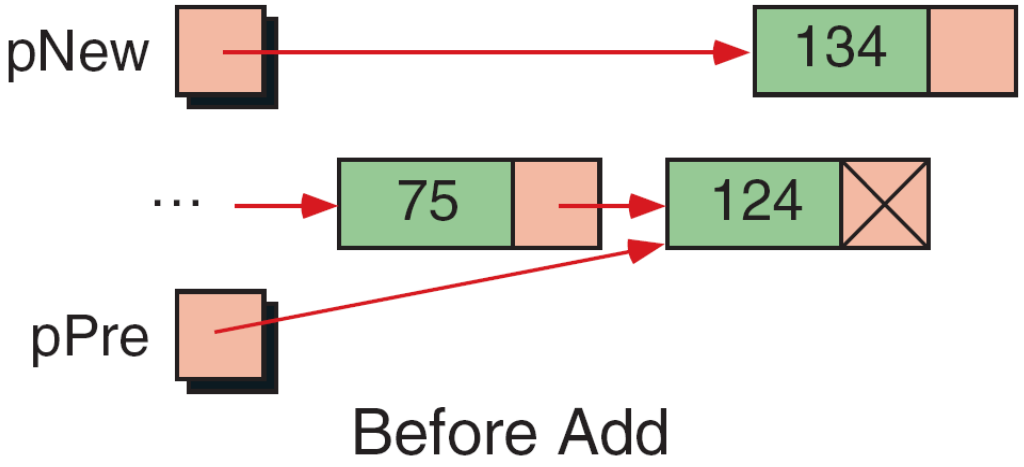
Before Add

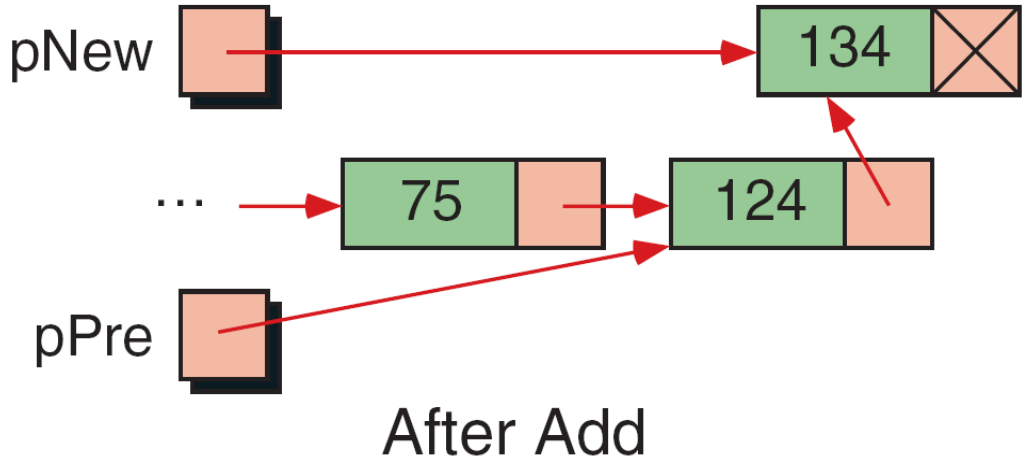


After Add

Insert a Node at End

```
pNew->link = pPre->link;
pPre->link = pNew;
```

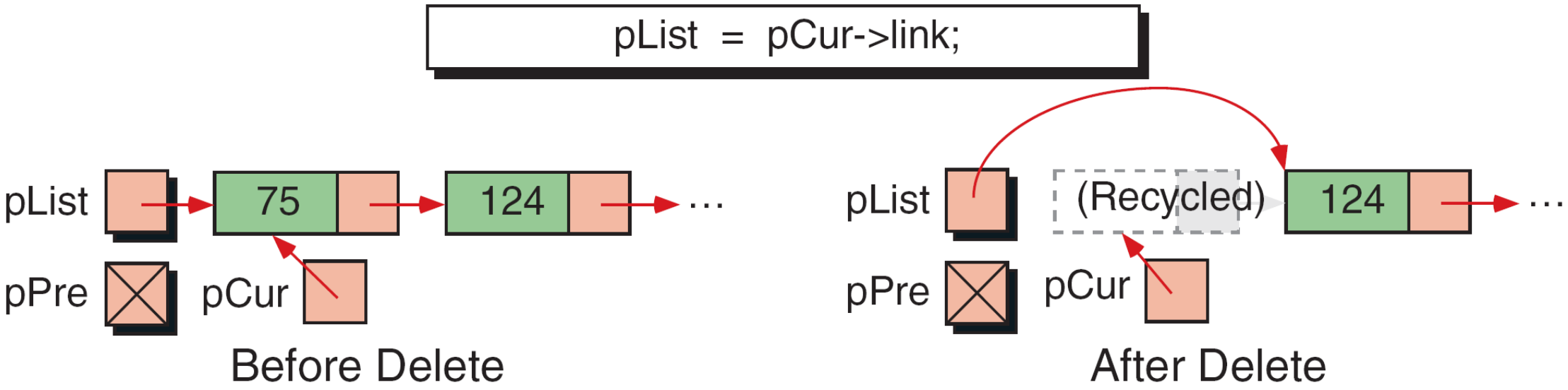




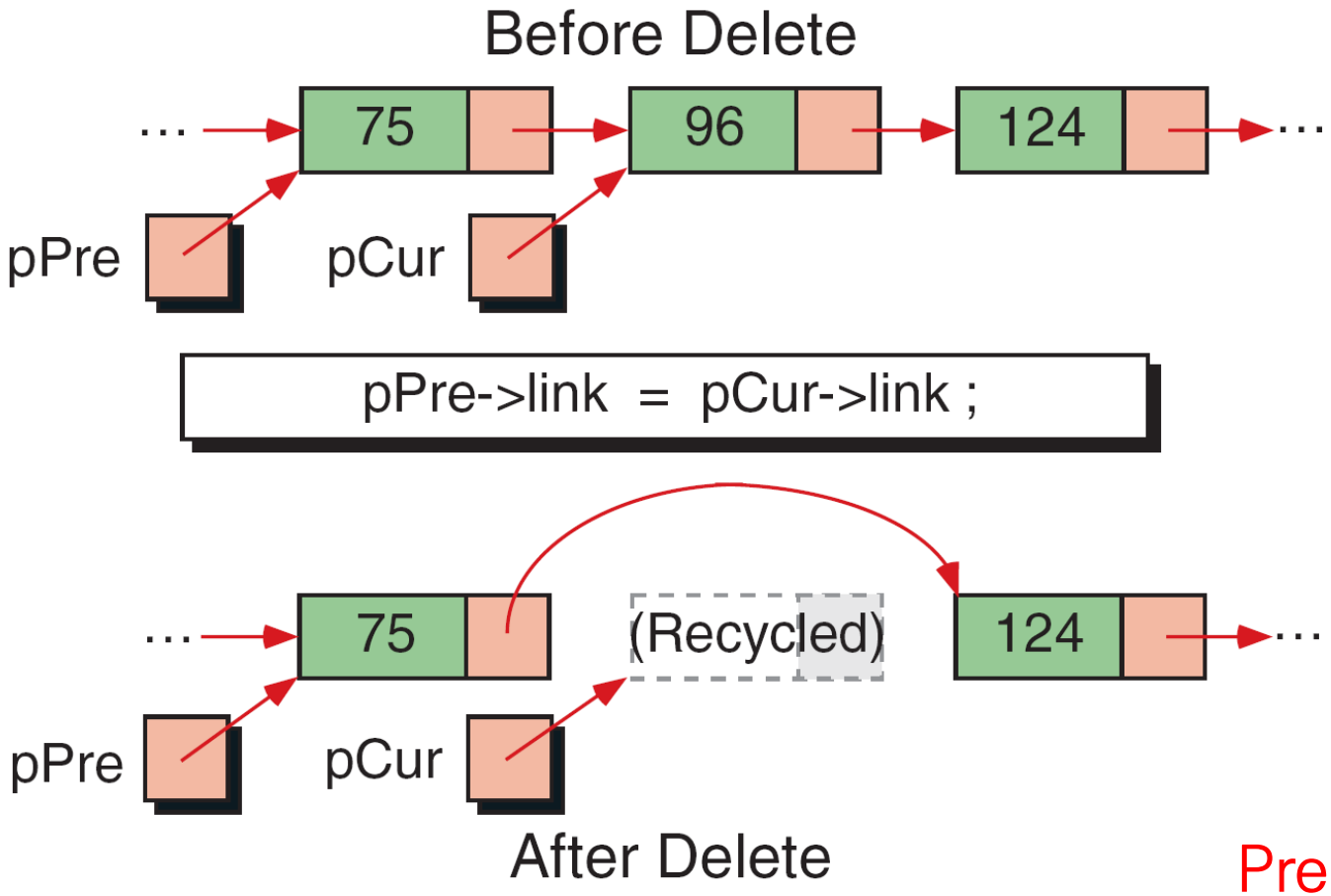
Insert a Node – Code

```
 8  NODE* insertNode (NODE* pList, NODE* pPre, DATA item)
 9  {
10  // Local Declarations
11     NODE* pNew;
12
13  // Statements
14     if (!(pNew  = (NODE*)malloc(sizeof(NODE))))
15         printf("\aMemory overflow in insert\n"),
16                exit (100);
17
18     pNew->data = item;
19     if (pPre == NULL)
20        {
21         // Inserting before first node or to empty list
22         pNew->link  = pList;
23         pList       = pNew;
24        } // if pPre
25     else
26        {
27         // Inserting in middle or at end
28         pNew->link = pPre->link;
29         pPre->link = pNew;
30        } // else
31     return pList;
32  }  // insertNode
```

Delete First Node



Delete – General Case



Pre, Cur 두 개가
같이 움직이는 거 주의!!

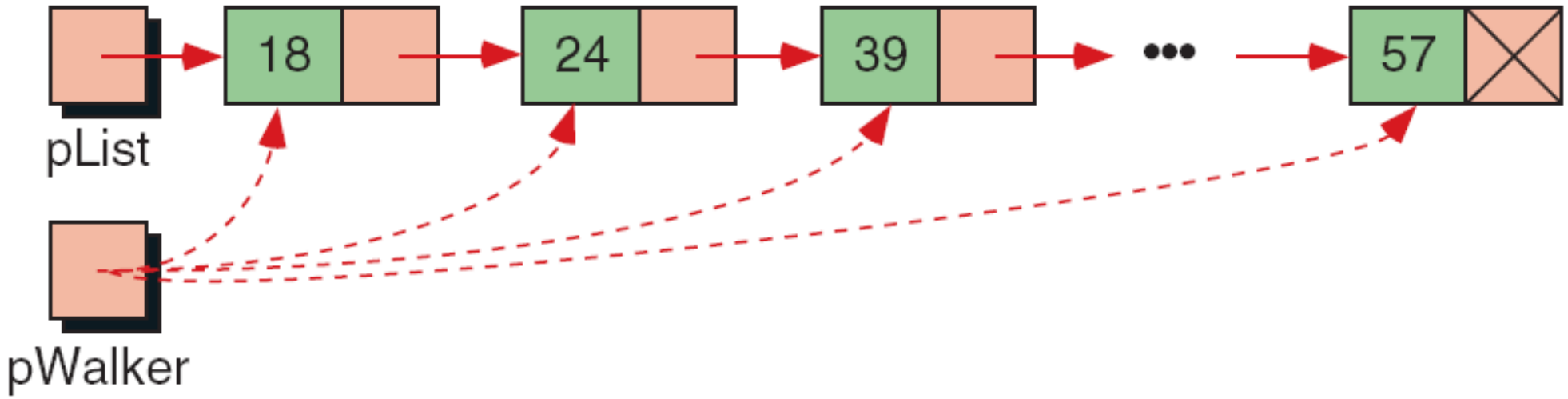
Delete a Node – Code

```
1  /* ==================== deleteNode ====================
2     This function deletes a single node from the link list.
3        Pre   pList is a pointer to the head of the list
4              pPre points to node before the delete node
5              pCur points to the node to be deleted
6        Post  deletes and recycles pCur
7              returns the head pointer
8  */
9  NODE* deleteNode (NODE* pList, NODE* pPre, NODE* pCur)
10 {
11 // Statements
12    if (pPre == NULL)
13       // Deleting first node
14       pList = pCur->link;
15    else
16       // Deleting other nodes
17       pPre->link = pCur->link;
18    free  (pCur);
19    return pList;
20 }  // deleteNode
```

Search Linear List

```
//리스트 pList가 있다.
struct Node *pWalker = pList;
while(pWalker)
{
        If(pWalker->data == 찾는 데이터)
                return 1;
        pWalker = pWalker->next;
}
return 0;
```

Linear List Traversal



Print Linear List

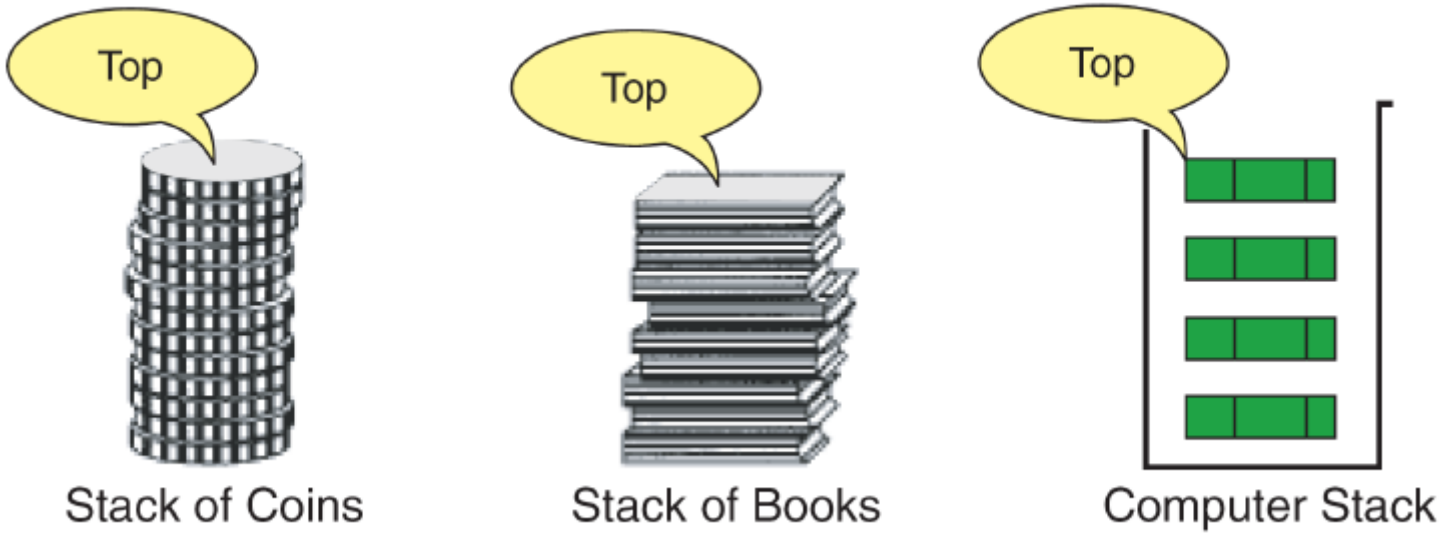
```
5  void printList (NODE* pList)
6  {
7  // Local Declarations
8     NODE* pWalker;
9
10 // Statements
11    pWalker = pList;
12    printf("List contains:\n");
13
14    while (pWalker)
15       {
16        printf("%3d ", pWalker->data.key);
17        pWalker = pWalker->link;
18       } // while
19    printf("\n");
20    return;
```

Average Linear List

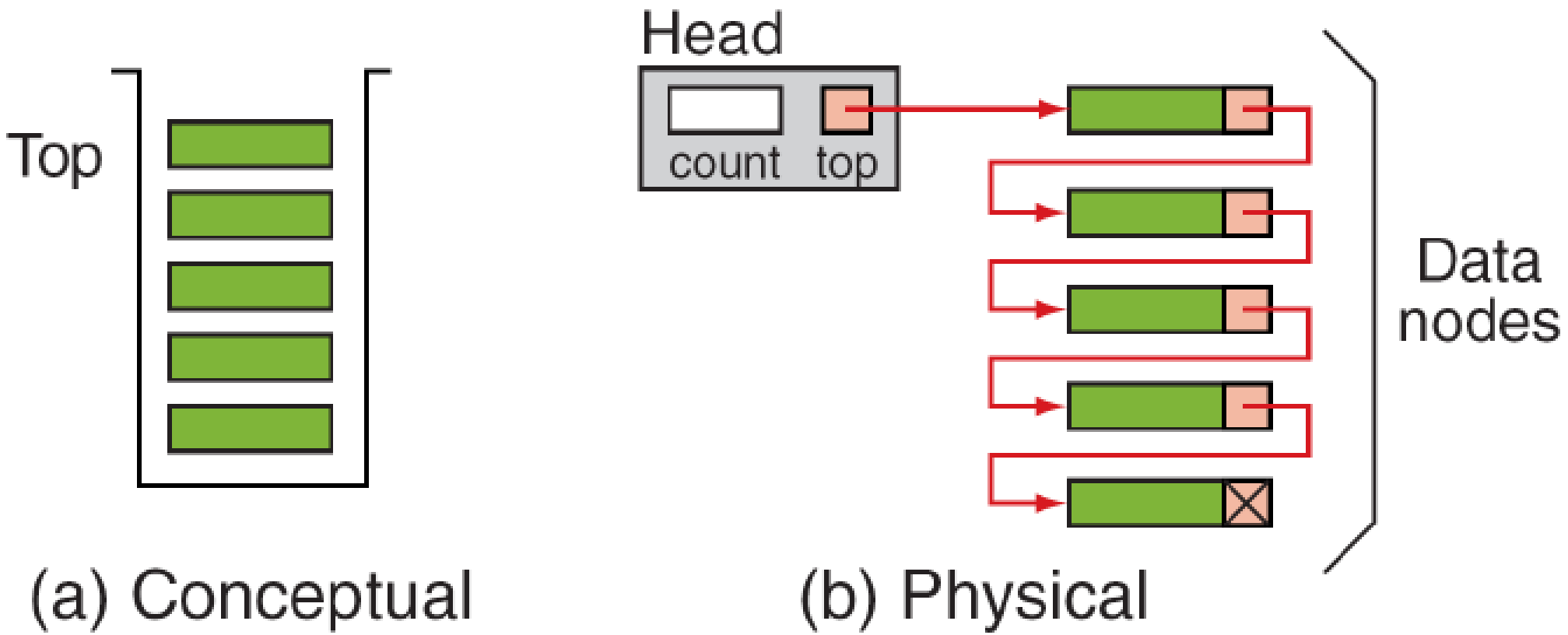
```
 5  double averageList (NODE* pList)
 6  {
 7  // Local Declarations
 8     NODE* pWalker;
 9     int   total;
10     int   count;
11
12  // Statements
13     total   = count = 0;
14     pWalker = pList;
15     while (pWalker)
16        {
17         total += pWalker->data.key;
18         count++;
19         pWalker = pWalker->link;
20        } // while
21     return (double)total / count;
22  } // averageList
```

Stack

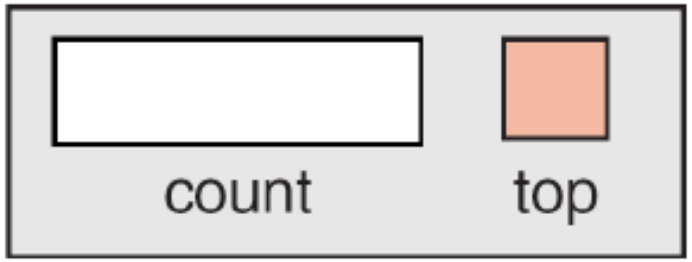
- Last in First out (LIFO)의 데이터 스트럭쳐
- Insertion과 deletion이 항상 한쪽 끝(Top)에서만 일어난다.
- Push : 새로운 것을 넣는 작업
- Pop : 젤 위에서 하나 빼는 작업



Stack Implementations



Stack Data Structure

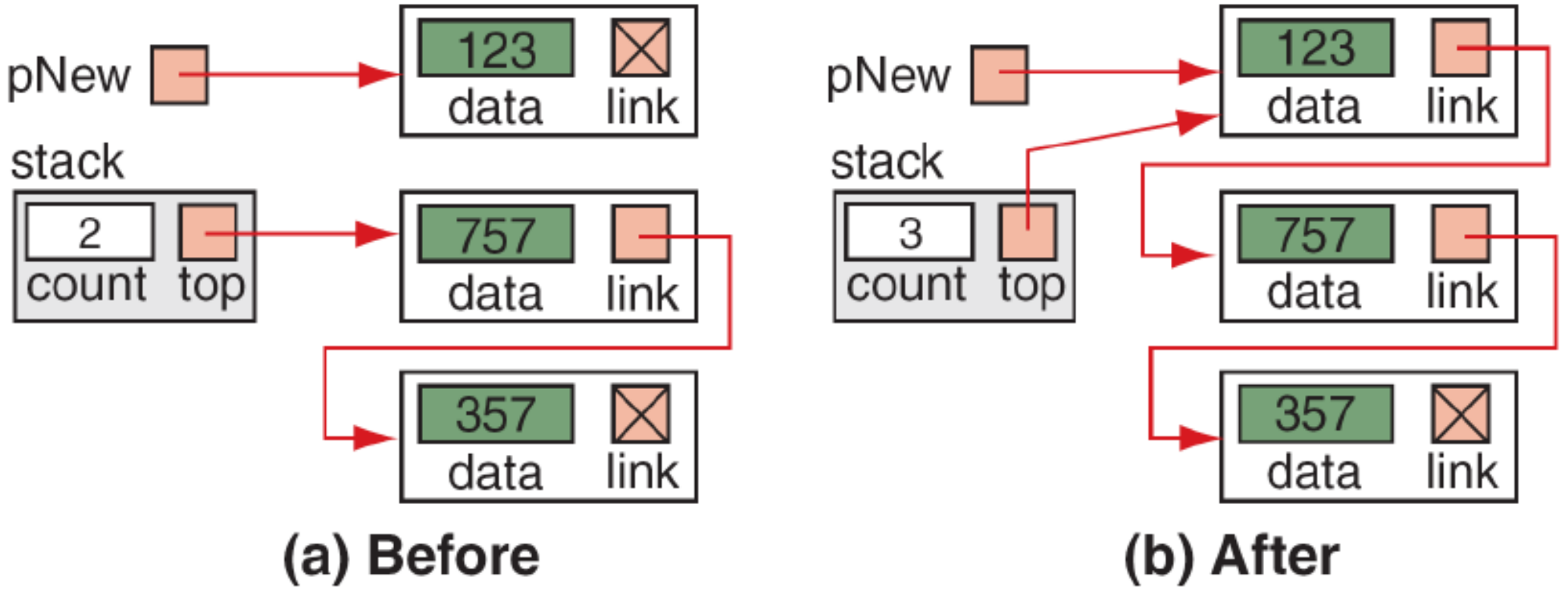


Stack Head Structure

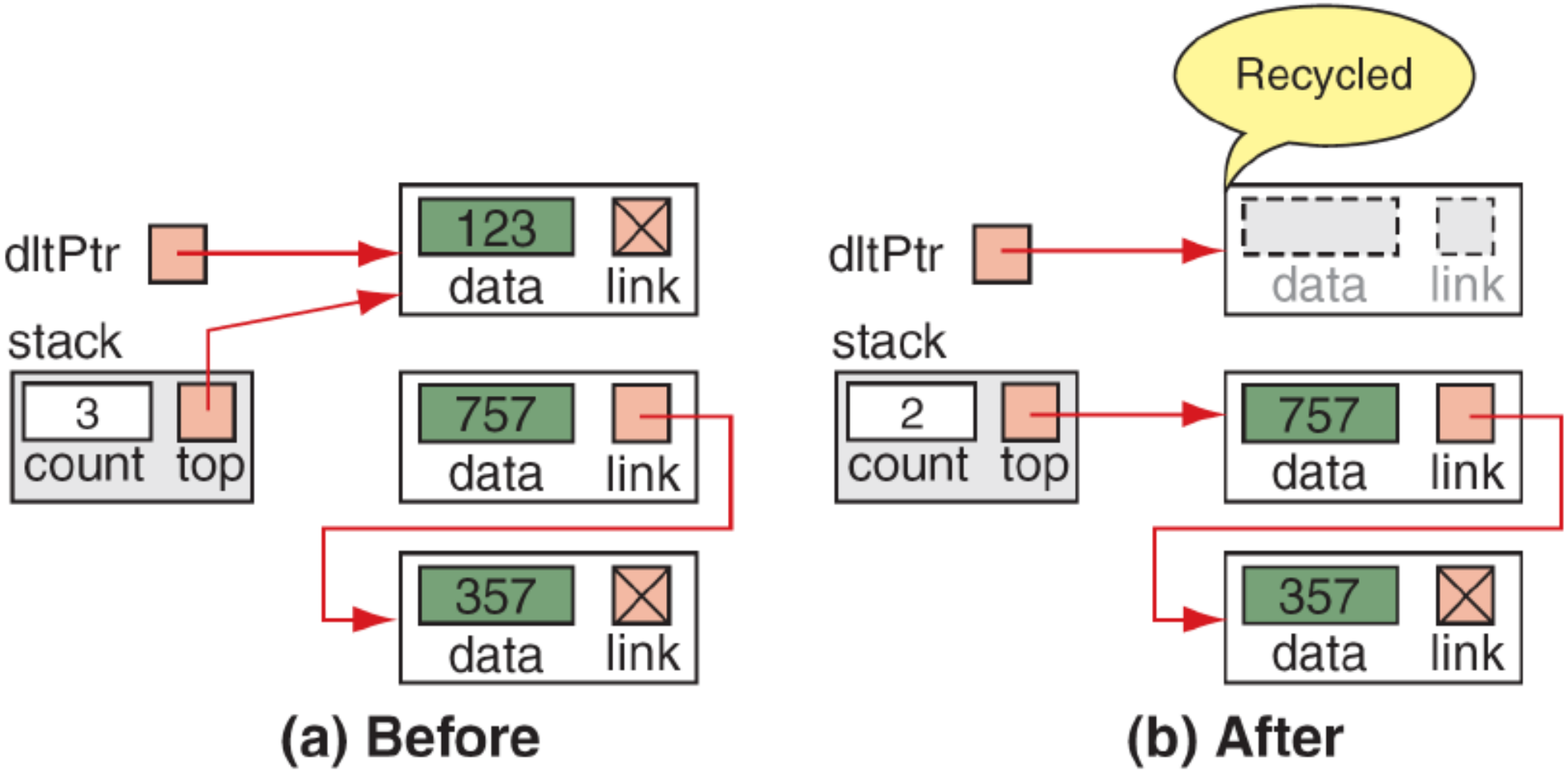
Stack Node Structure

```
typedef struct
    {
     int            count;
     struct node*   top;
    } STACK;
typedef struct node
    {
     int            data;
     struct node*   link;
    } STACK_NODE;
```

Stack _ Push

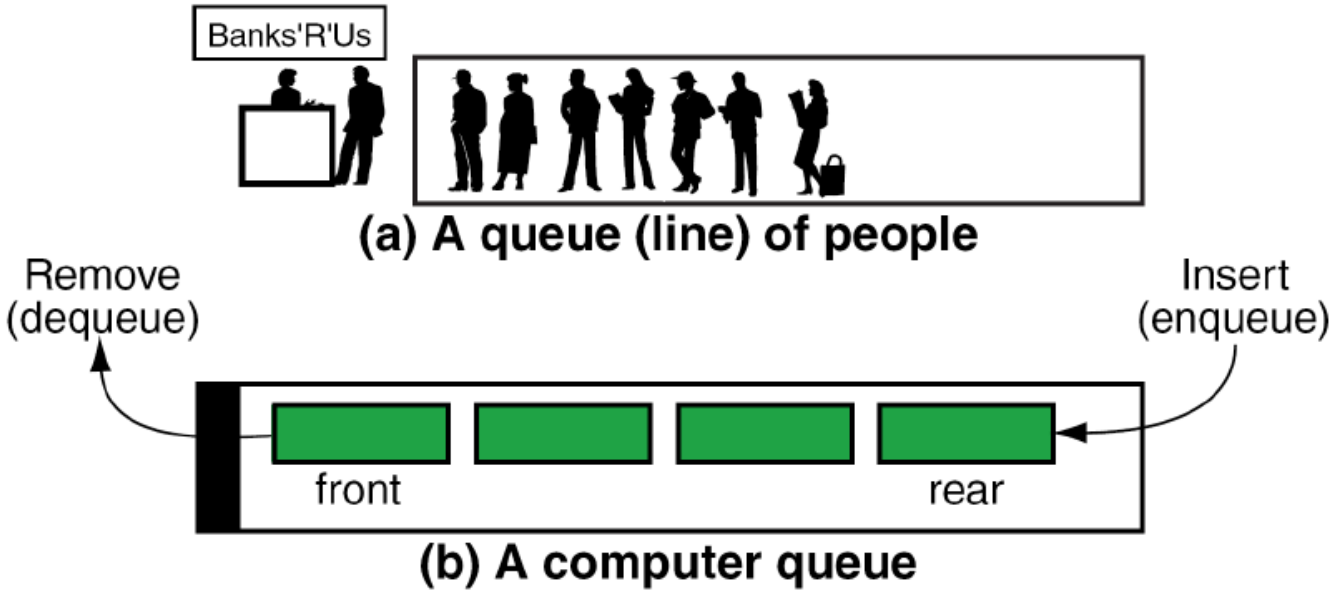

pNew
123
data
link
stack
2
count
top
757
data
link
357
data
link
(a) Before
pNew
123
data
link
stack
3
count
top
757
data
link
357
data
link
(b) After

Stack _ Pop

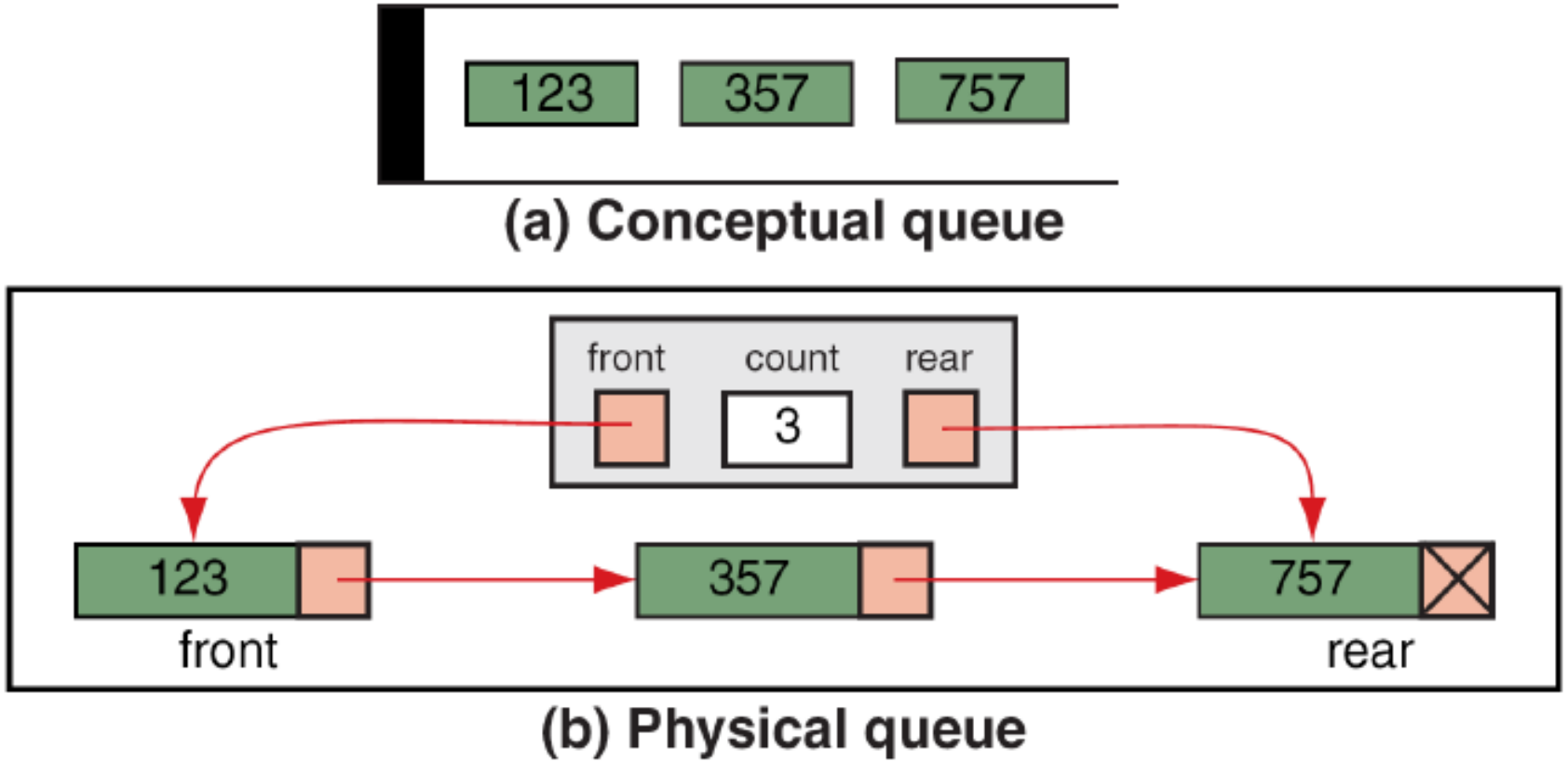

dltPtr
stack
3
count
top
123
data
link
757
data
link
357
data
link
(a) Before
Recycled
dltPtr
stack
2
count
top
data
link
757
data
link
357
data
link
(b) After

Queue

- First in First out(FIFO)의 데이터 스트럭쳐
- Insertion은 한쪽 끝, Deletion은 다른 한쪽 끝에서만 일어난다. :
- Enqueue : 큐에 새로운 걸 넣는 작업 (rear)
- Dequeue : 큐에서 하나를 제거하는 작업 (front)

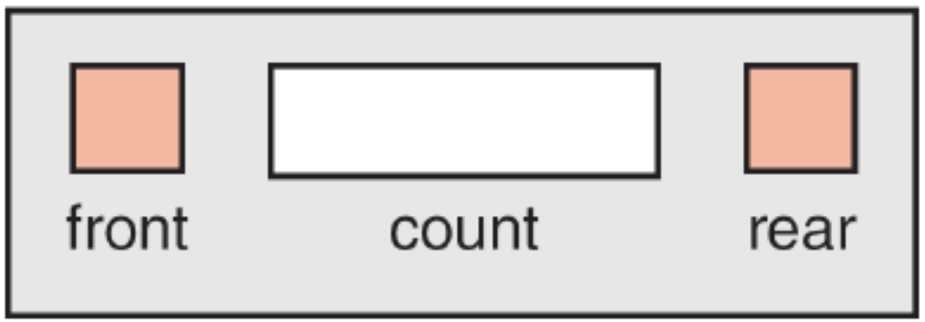


Queue Implementations



Queue Data Structure

Node Structure

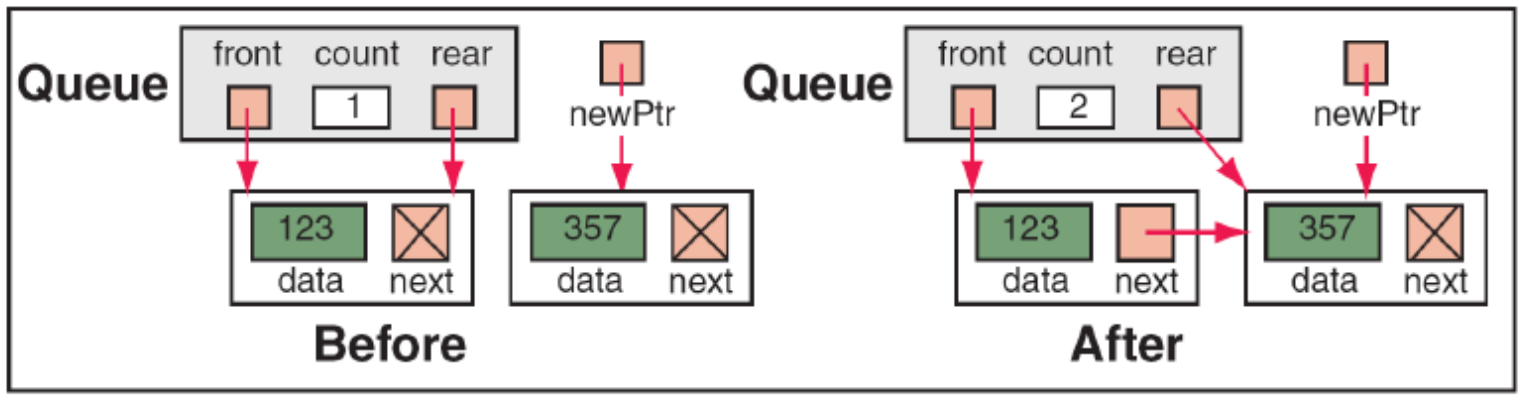


Head Structure

```
typedef struct node
    {
     int            data;
     struct node*   next;
    } QUEUE_NODE;

typedef struct
    {
     QUEUE_NODE*  front;
     int          count;
     QUEUE_NODE*  rear;
    } QUEUE;
```

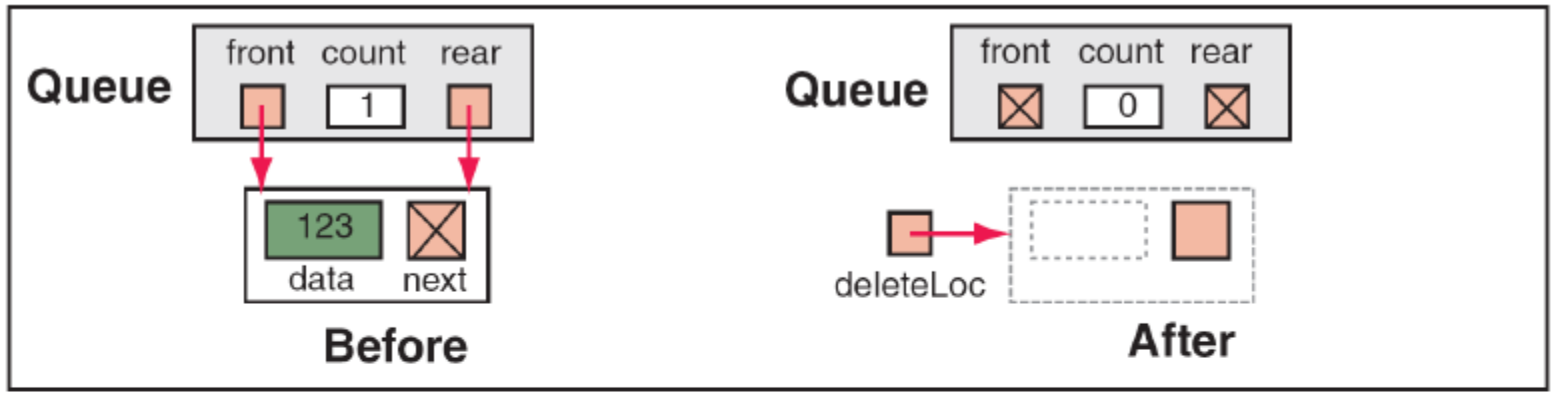
Enqueue

(a) Case 1: Insert into Null Queue

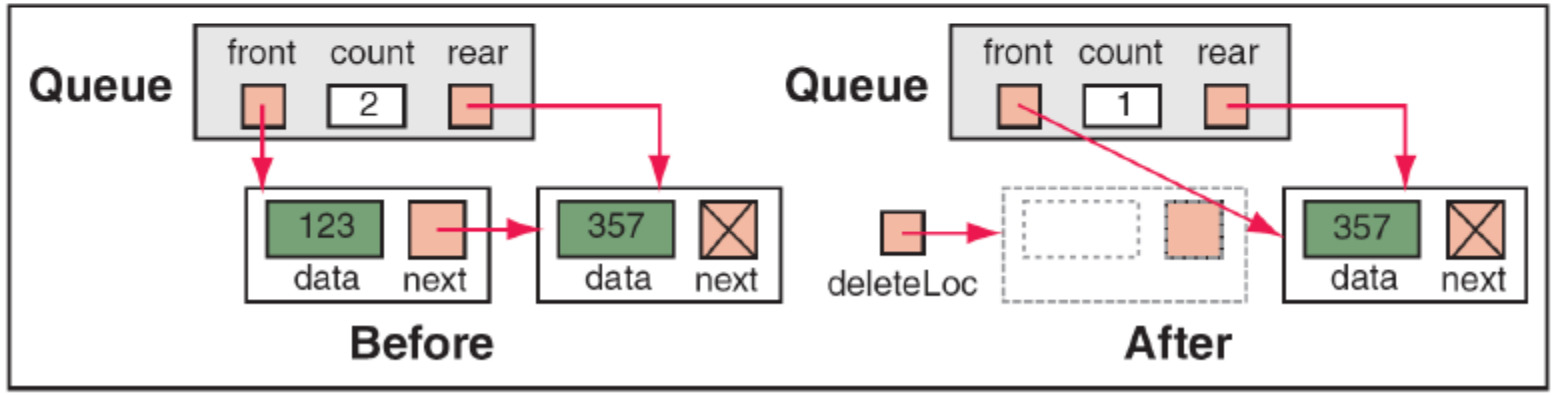


(b) Case 2: Insert into Queue with Data

Dequeue



(a) Case 1: Delete only item in queue



(b) Case 2: Delete item at front of queue

한 학기 배운 것 총 정리

- 책에 사이사이 박스에 있는 예제 코드들 전부 다 한번씩 쭉 보고 이해하기. 코드가 있는 거는 충분히 시험에 코드 짜는 문제로 나올 수 있다!
- Data Structure에서는 다양한 Implementation이 있기 때문에 무작정 외우기 보다는 어떻게 구현하는지 Concept들을 꼭 기억
- DS부분은 코드 반드시 봐야 합니다.
- 빨간색 글씨로 된 거 기억하기