전산 SMP 9주차

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지난 내용 복습

Dynamic Memory Allocation

왜 쓰나요?

- 배열의 크기를 입력 받아 그 크기만큼의 배열을 만들고 싶을 때

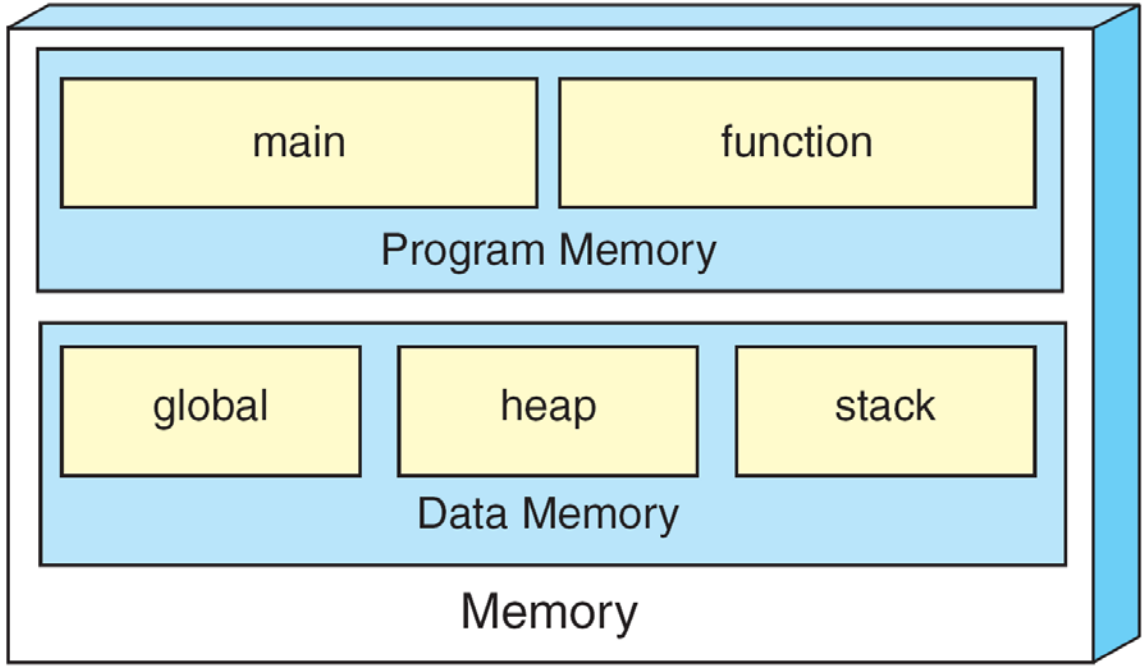
```
int main(void) {
    int size;

    scanf("%d", &size);

    int array[size];
}
```

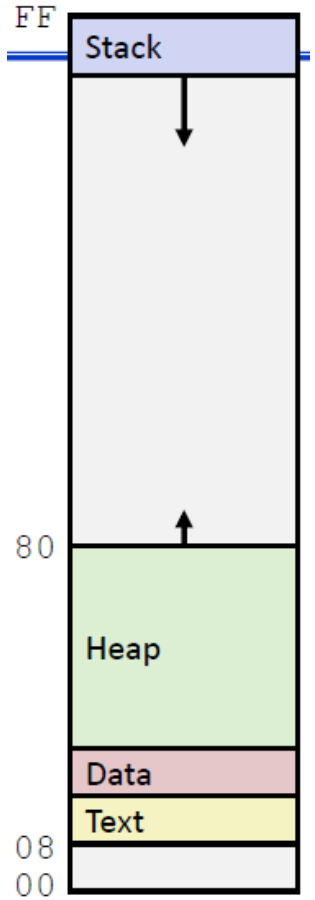
Compile Error! 선언은 항상 맨 위에 와야 한다.
선언 후에 배열이 할당되어야 하는데… 이럴 때는 어떻게?

- 프로그램 실행 중에 메모리를 할당해 데이터를 저장할 공간을 생성하는 방법

A Conceptual View of Memory

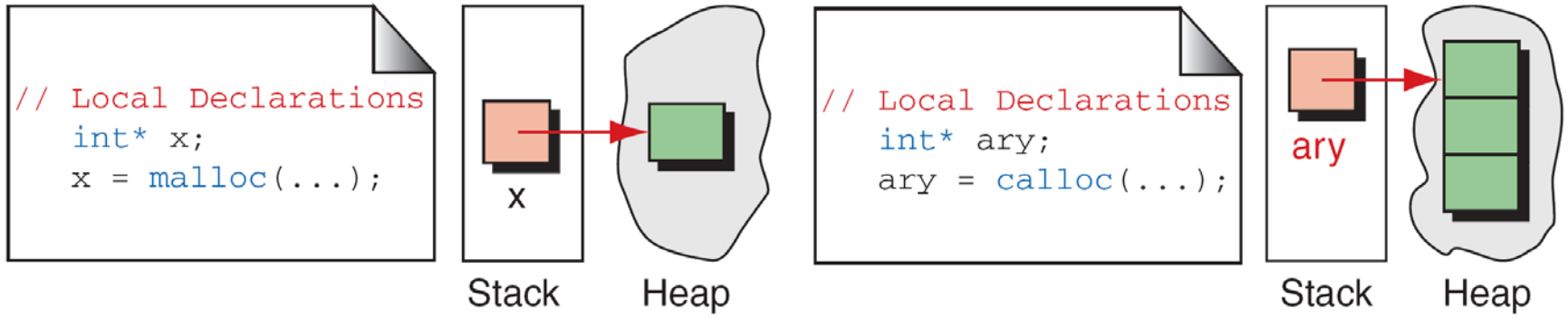
- We can refer to memory allocated in the heap only through a pointer.





Accessing Dynamic Memory

(a) Static Memory Allocation

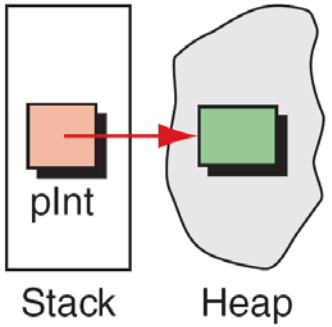


(b) Dynamic Memory Allocation

malloc

- 지정하는 크기(byte) 만큼 메모리(힙)를 할당
- 기본적으로 void *로 리턴 → 원하는 타입으로 Cating 해줘야 한다
- 할당에 실패한 경우 NULL 리턴
- void *malloc (size_t size);

```
if (!(pInt = malloc(sizeof(int))))
    // No memory available
    exit (100) ;
// Memory available
…
```



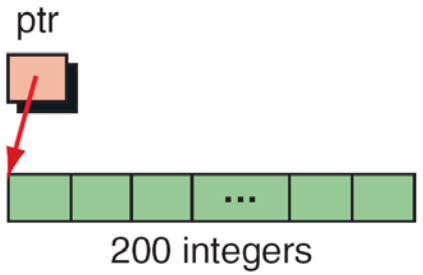
- int* p = (int *)malloc(sizeof(int) * 4);
  - int형의 크기가 4byte이기 때문에 16byte의 공간이 동적으로 할당
- char *str = (char *)malloc(sizeof(char) * 10);

calloc

- void *calloc (size_t element_count, size_t element_size);

- int *p = (int *)calloc(4, sizeof(int));
- char *str = (char *)calloc(10, sizeof(char));

malloc(sizeof(int)*4) ↔ calloc(4, sizeof(int))




```
if (!(ptr = (int*)calloc (200, sizeof(int))))
    // No memory available
    exit (100) ;

// Memory available
…
```

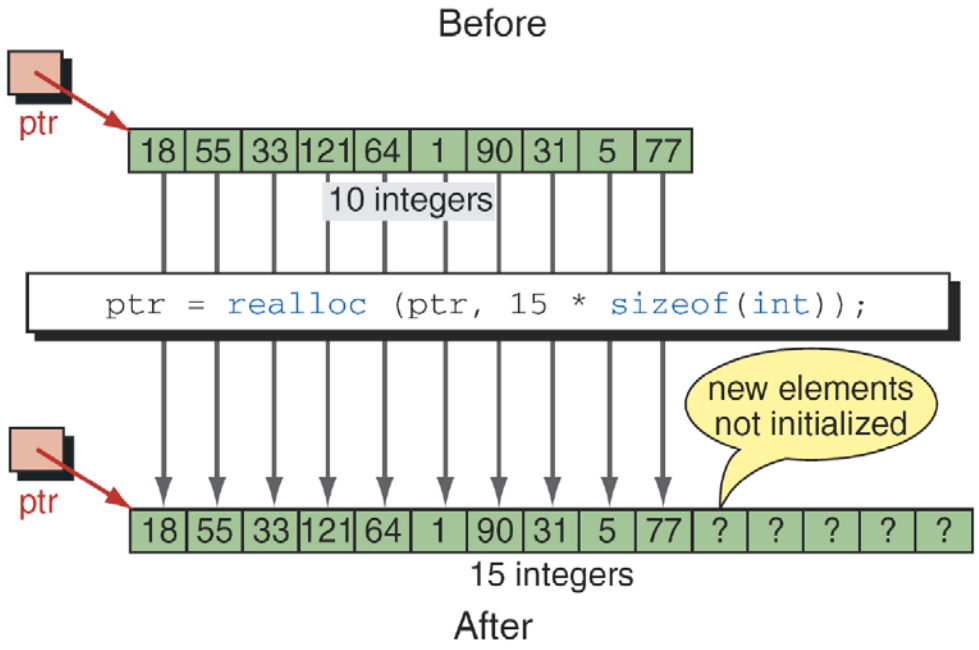
realloc

- 할당받은 메모리 공간을 새로운 크기로 재할당

- void *realloc(void *ptr, size_t newSize);

- int *p = (int *)calloc(4, sizeof(int));
  p = (int *)realloc(p, sizof(int) * 6);

- char *str = (char *)calloc(10, sizeof(char));
  str = (char *)realloc(str, 20*sizeof(char));

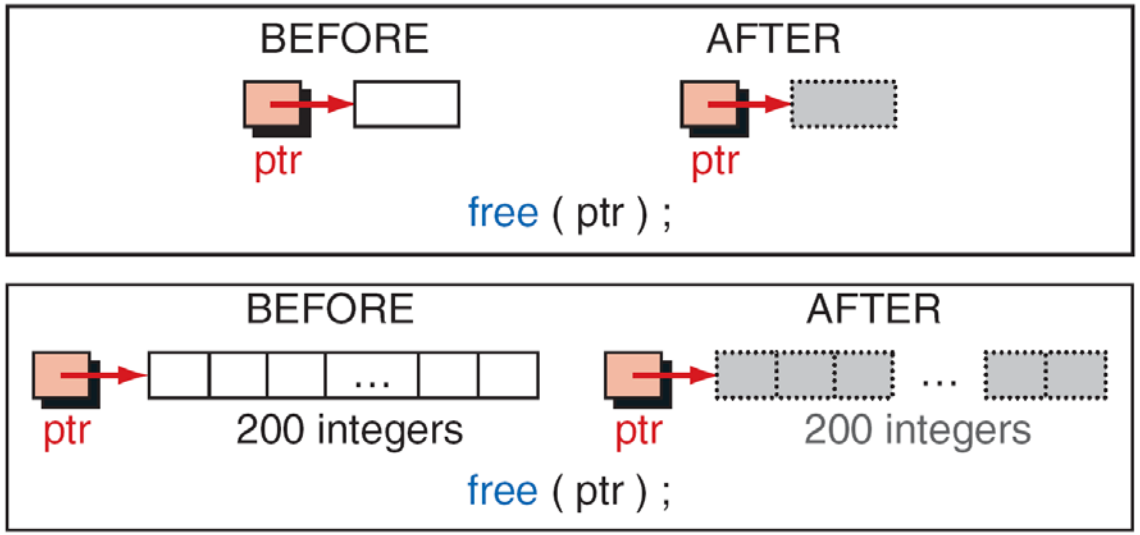


free

- 동적 할당한 메모리 반환
- 사용하지 않을 때 & 프로그램의 마지막에 반드시 반환해야 한다!

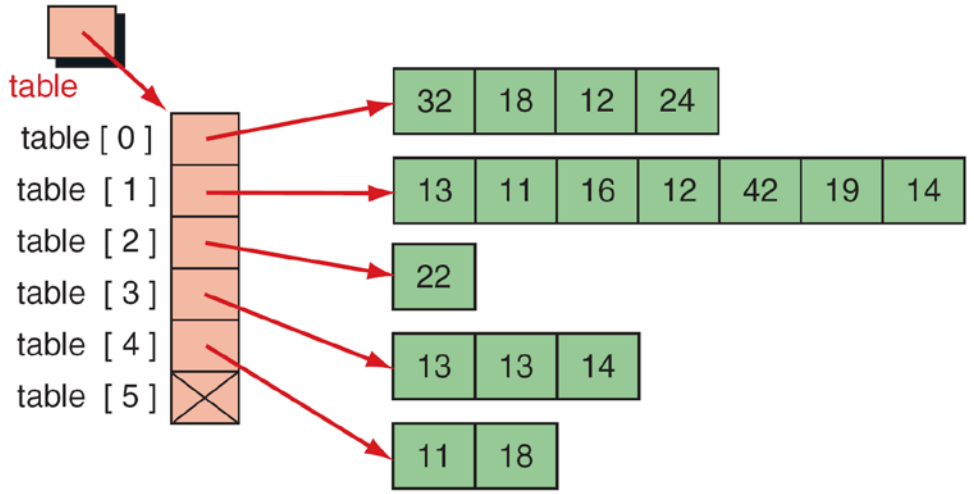
- void free (void * ptr);

- free(p);
- free(str);



동적할당으로 2차원 배열 – 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;
```

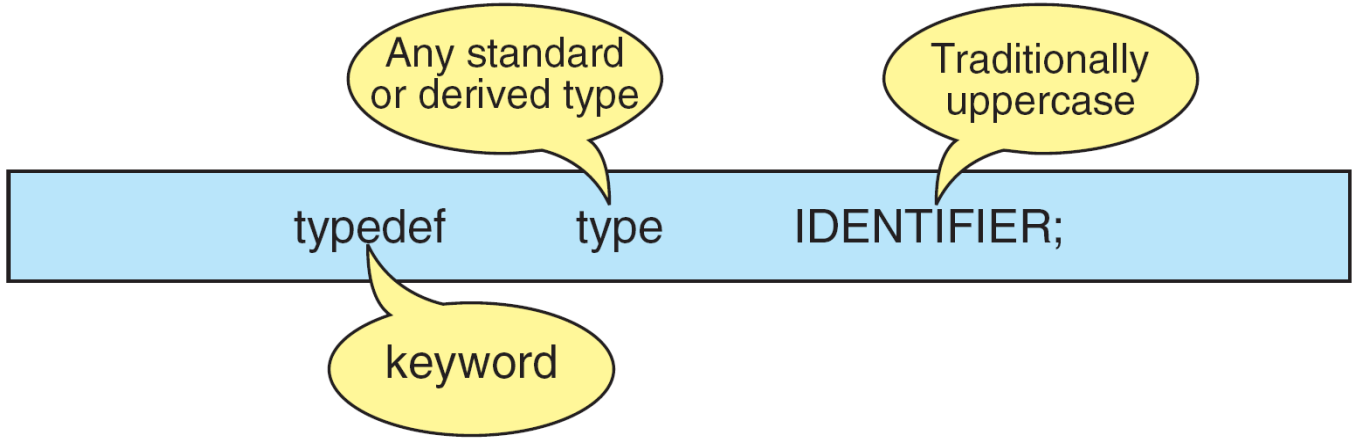
오늘 할 것

- Enumeration, Structure, Union
- String (Advanced) – 하는 데 까지

Structure

The Type Definition (typedef)

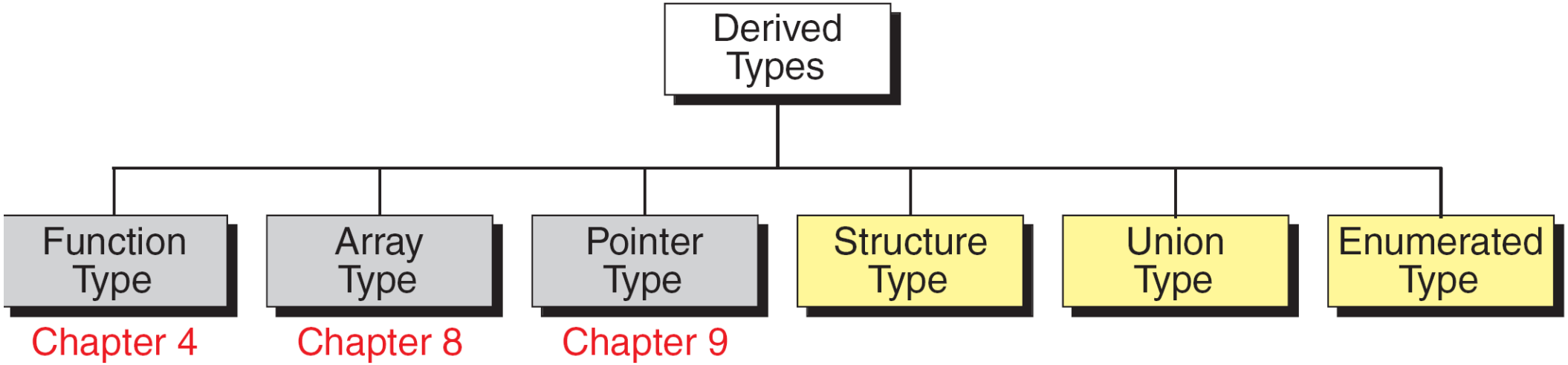
- A type definition, typedef, gives a name to a data type by creating a new type that can then be used anywhere a type is permitted.
- 프로그래머는 길게 쓰는 것을 싫어한다



typedef int INGETER;

Derived Type

- 프로그래머가 임의로 만든 타입



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

Declaring an Enumerated Type

- enum typeName {identifier list};
- enum color {RED, BLUE, GREEN, WHITE};
- enum color skyColor;

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};

Operations on Enumerated Types

- enum color x, y;
  x = BLUE; x = y;

- if (color1 == color2)
  if (color1 == BLUE)

- Switch (color1)
  {
  case BLUE: …

Enumeration Type Conversion

- int형과 자동으로 호환됨

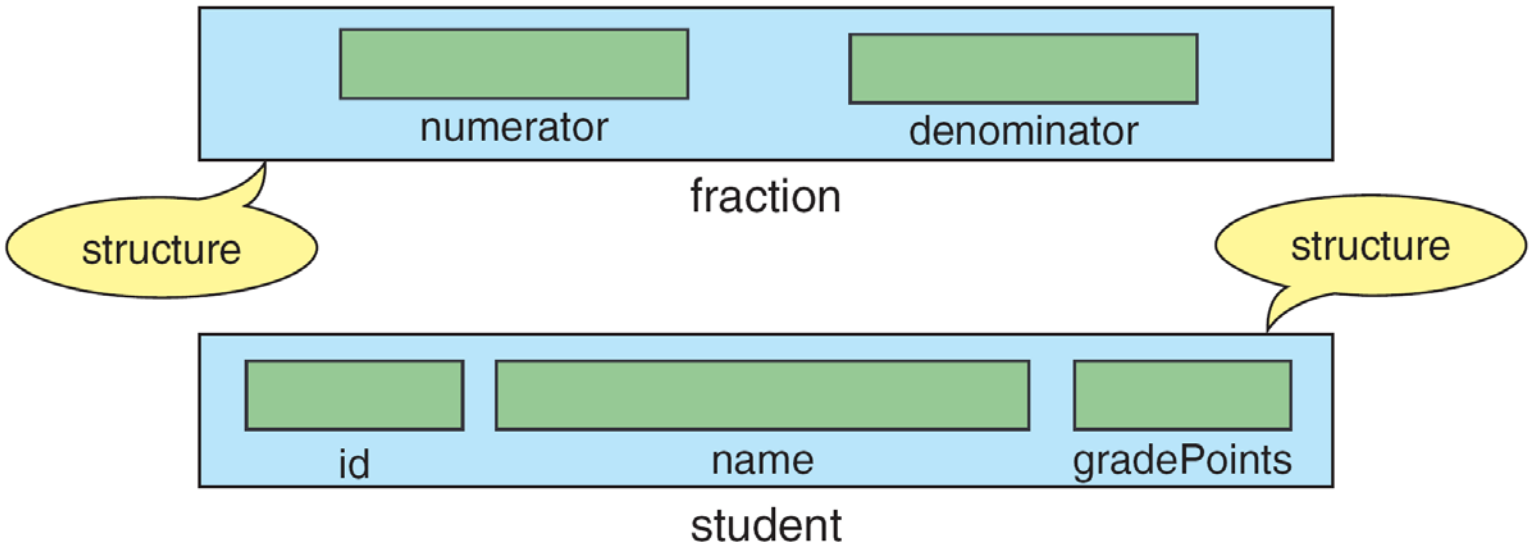
- int x; enum color y;
  x = BLUE; y = 2;
- enum color y;
  y = (enum color) 2;

Anonymous Enumeration: Constants

- enum {space = ‘ ‘, comma = ‘,’, color = ‘:’};
- enum {OFF, ON};

Structure Type

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



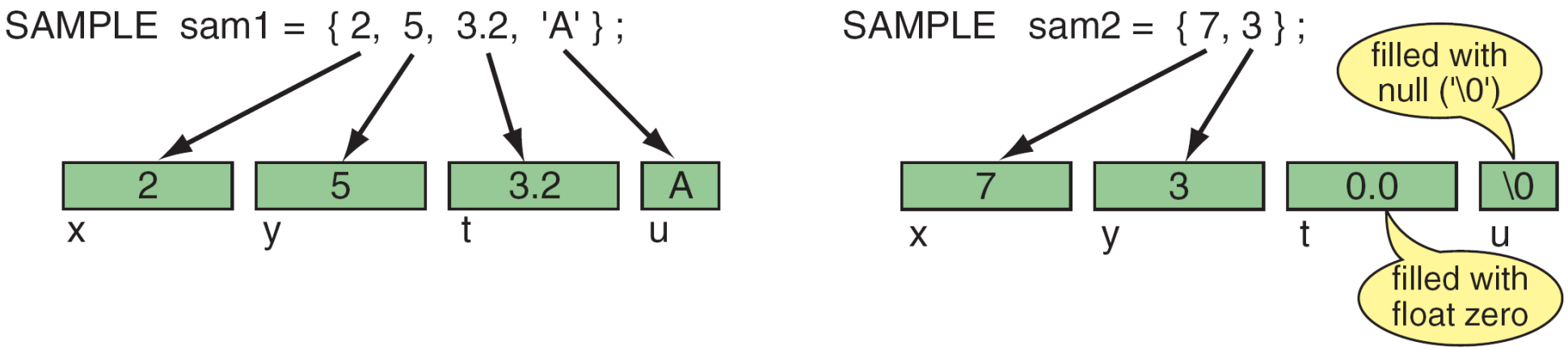
Structure Declaration

```
// Global Type Declarations
struct STUDENT
    {
     char id[10];
     char name[26];
     int  gradePts;
    } ;

// Local Declarations
struct STUDENT aStudent;
```

```
// Global Type Declarations
typedef struct
    {
     char id[10];
     char name[26];
     int  gradePts;
    } STUDENT;

// Local Declarations
STUDENT aStudent;
```

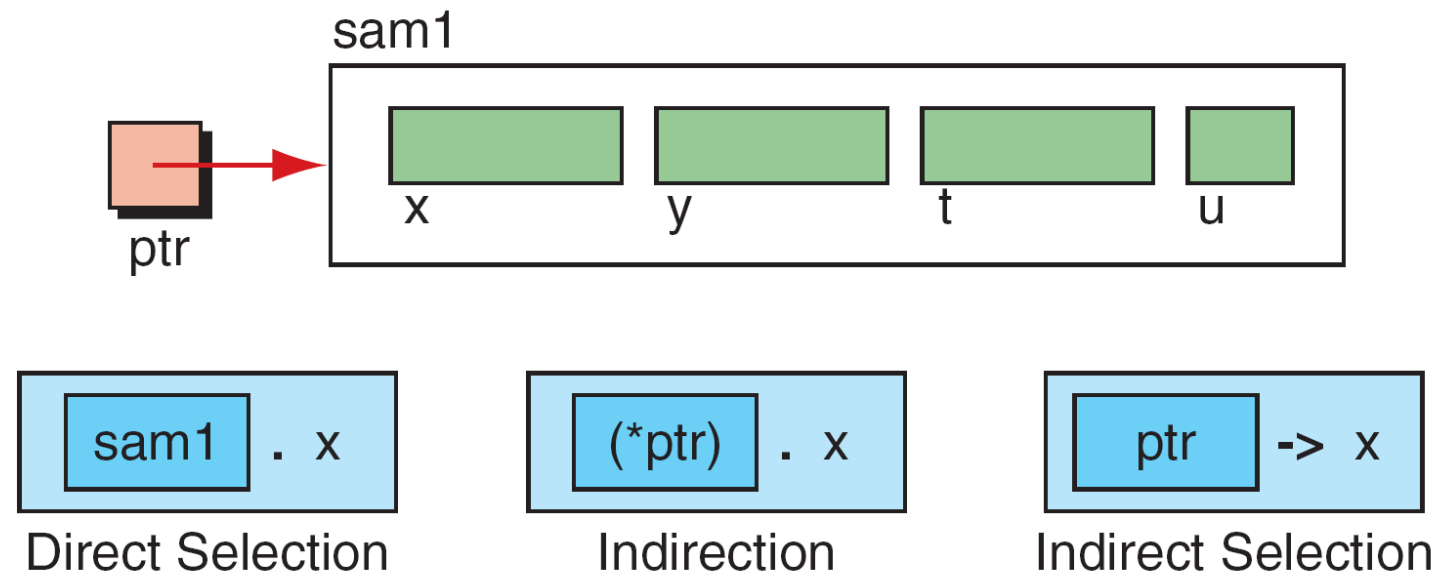
Initializing Structures

```
typedef struct
   {
    int   x;
    int   y;
    float t;
    char  u;
   } SAMPLE;
```



Accessing Structure Elements

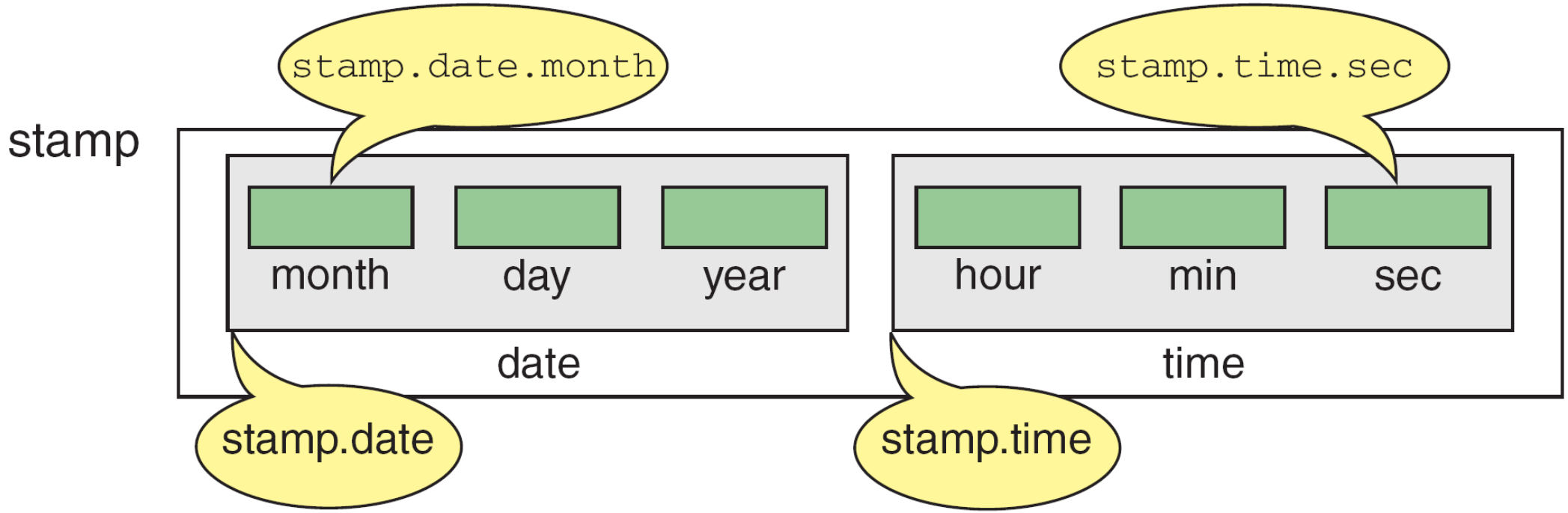
```
typedef struct
  {
   int    x;
   int    y;
   float  t;
   char   u;
  } SAMPLE;
  …
  SAMPLE  sam1;
  SAMPLE* ptr;
  …
  ptr = &sam1;
  …
```



Three Ways to Reference the Field **x**

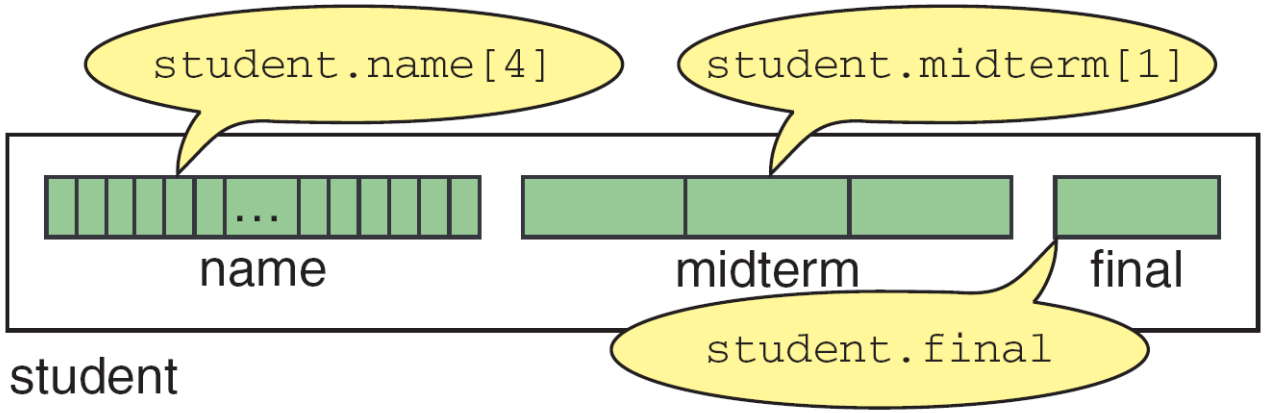
(*pointerName).fieldname ⟺ pointerName->fieldName.

Nested Structure

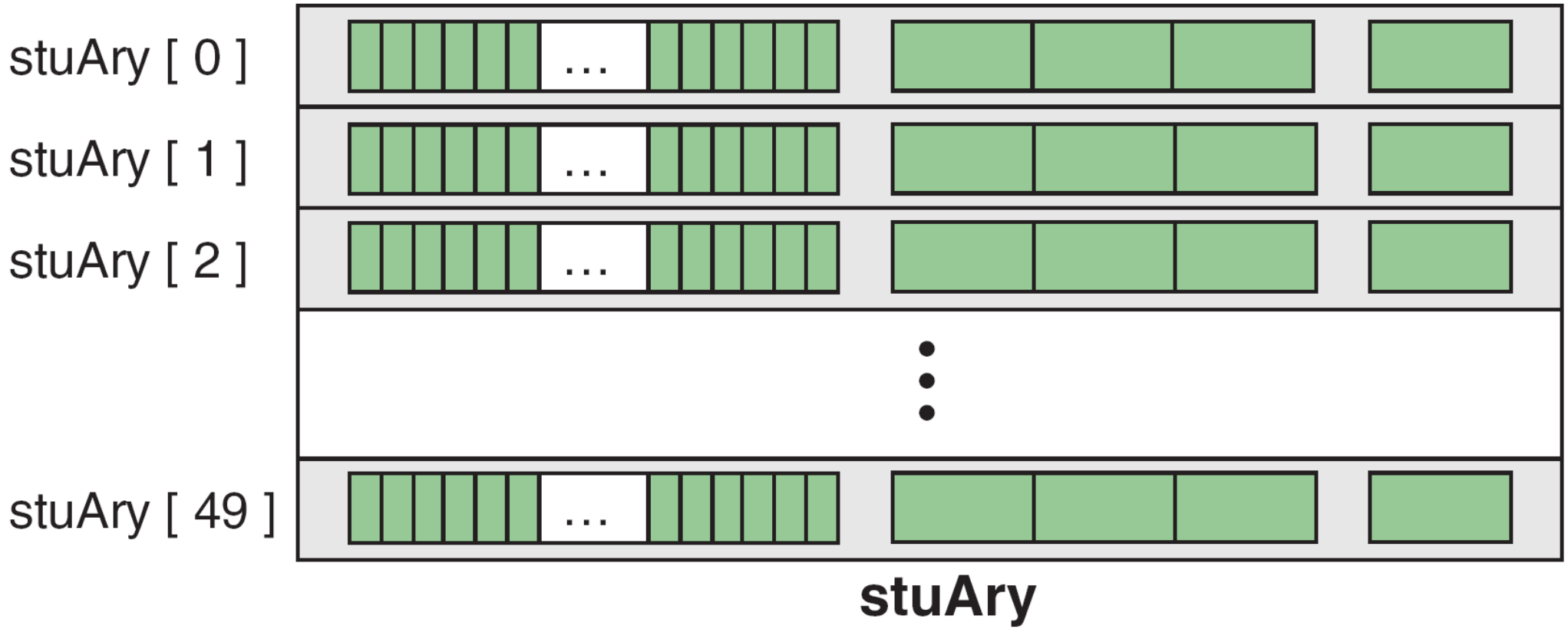


Arrays in Structures

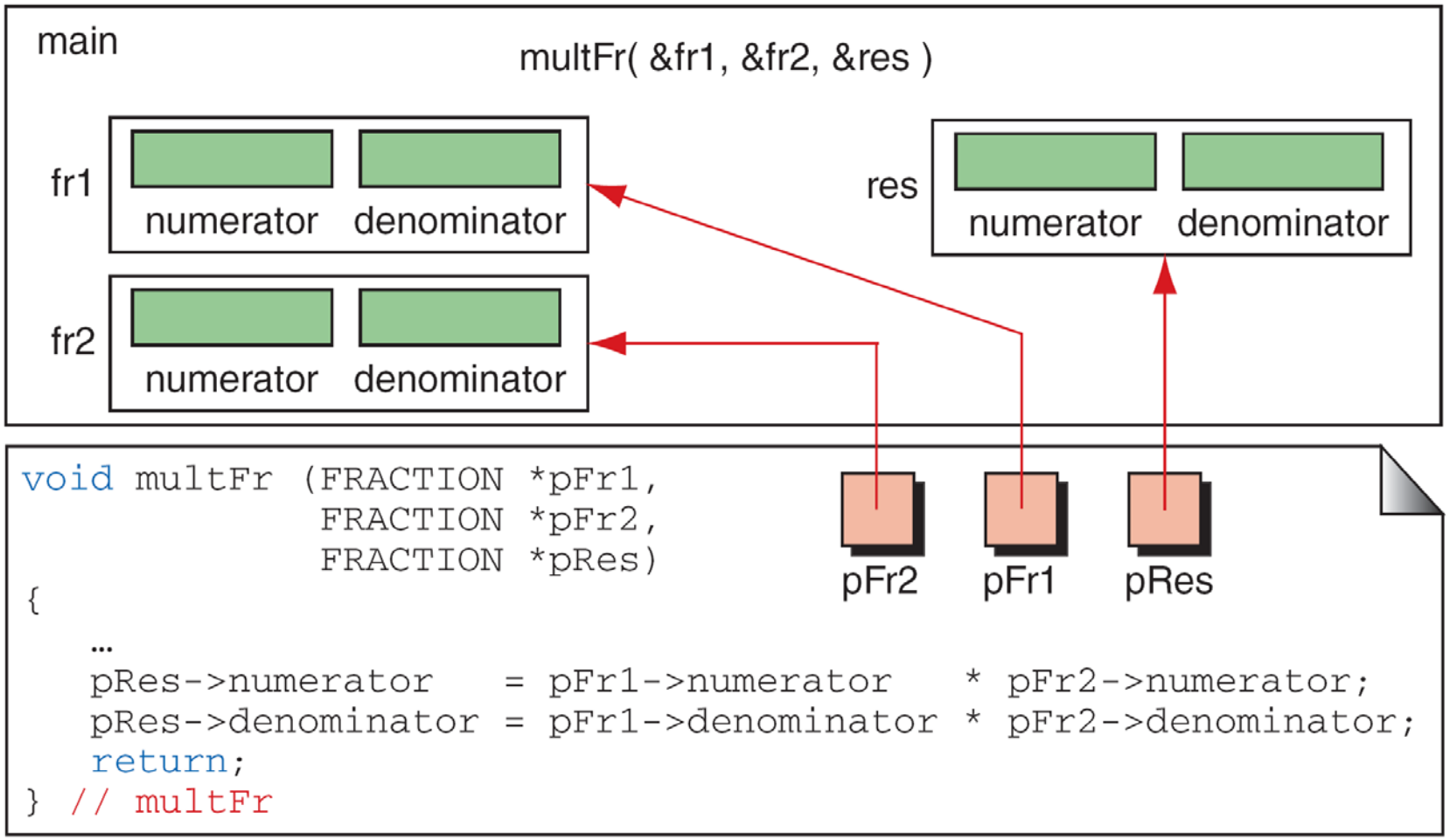
```
// Global Declarations
typedef struct
   {
    char name[26];
    int  midterm[3];
    int  final;
   } STUDENT ;
// Local Declarations
STUDENT student;
```



Array of Structures



Passing Structures Through Pointers



Structure Application

- Structure 배열 struct AA ary[10];
- Structure 포인터 배열 struct AA *ary[10];

- 한 Structure 안의 포인터 element가 다른 Structure를 가리킨다

→ Linked List의 핵심 개념!!

Example

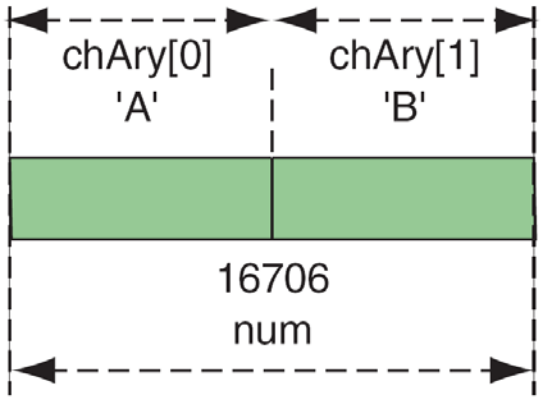
- 이름, 나이, 성별(enum), 학년(enum)을 포함하는 구조체
- 크기 5짜리 구조체 배열 만들고 여기 있는 사람에 대한 정보 하나씩 넣기
- for 문으로 각 구조체에 들어간거 전부 출력

학년	**성별**
FRESHMAN	MALE
SOPHOMORE	FEMALE
JUNIOR	
SENIOR	

Union Types

- 구조체와 비슷하다. 선언 및 사용도 구조체 처럼
- 단, Element 들이 메모리를 **공유**
- 전체 구조체 크기 = 구조체 내부의 가장 큰 변수의 크기

```
union shareData
    {
     char    chAry[2];
     short   num;
    };
```



Both `num` and `chAry` start at the same memory address. `chAry[0]` occupies the same memory as the most significant byte of `num`.

Example

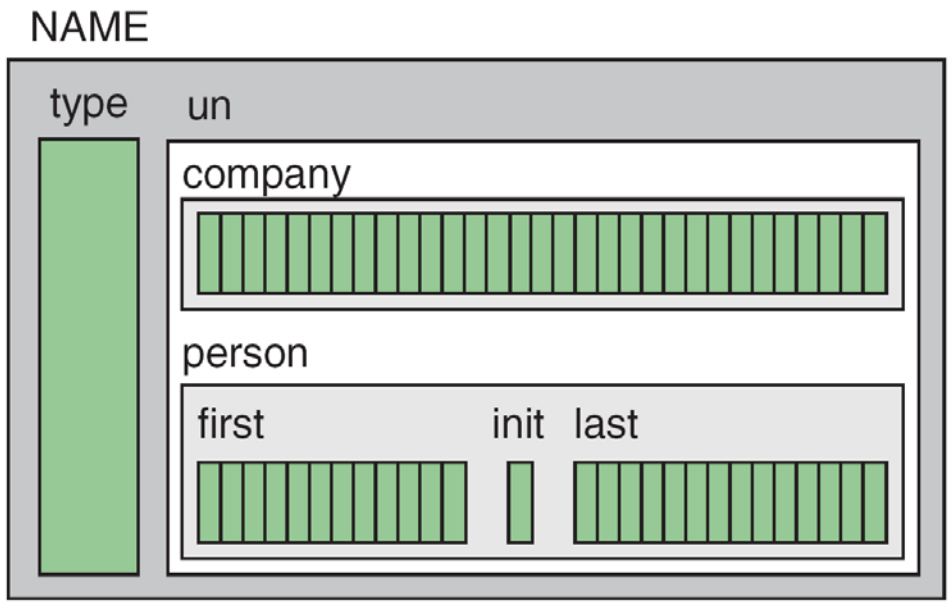
```
typedef union {
        short num;
        char  chary[2];
} SHORTCHAR;

SHORTCHAR data;
data.num = 16706;  // 1000001 01000010 = 65 66
```

```
printf("Short: %hd\n", data.num);
printf("Ch[0]: %c\n",  data.chAry[0]);
printf("Ch[1]: %c\n",  data.chAry[1]);
```

```
Results:
Short: 16706
Ch[0]: A
Ch[1]: B
```

Union Application

```
typedef struct
  {
   char  first[20];
   char  init;
   char  last[30];
  } PERSON;
typedef struct
  {
   char  type;
   union
     {
      char   company[40];
      PERSON person;
     } un;
  } NAME;
```



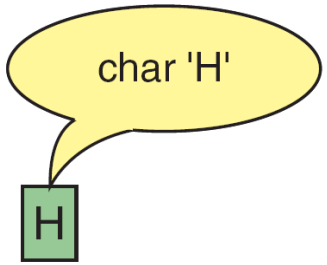
메모리 공간 절약할 수 있고, 두 가지 구조체 역할을 할 수 있으므로 간단

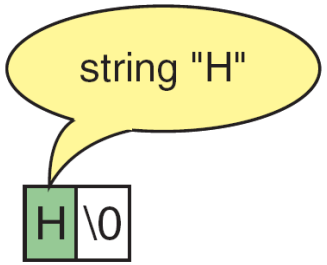
단, 헷갈리지 않는다면

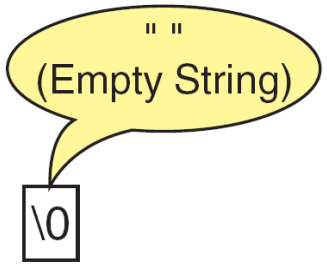
String

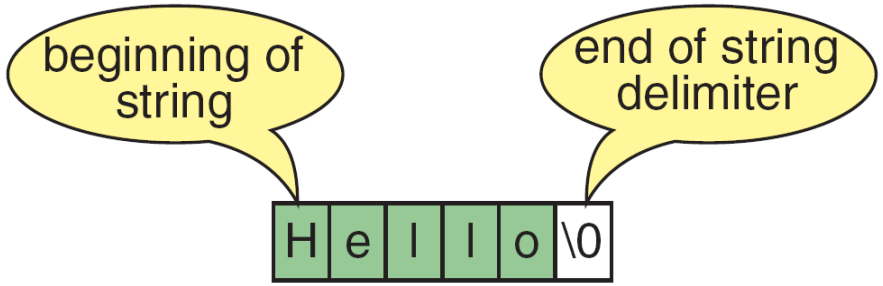
문자열(string)도 결국은 배열이다

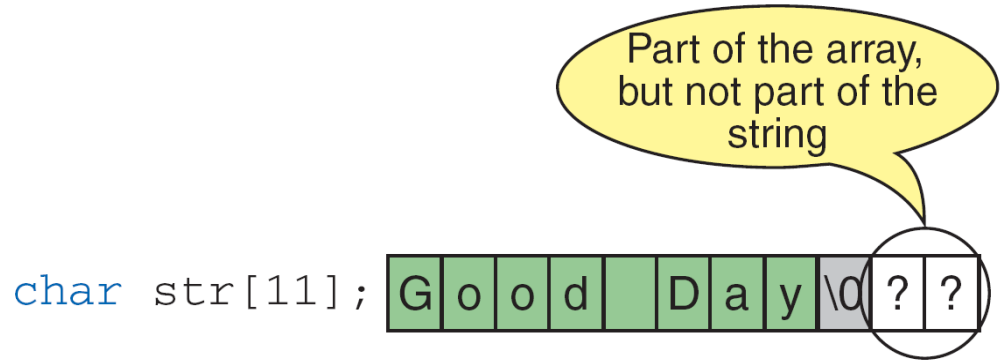
- char 형의 배열
- 끝에 널문자 '\0'

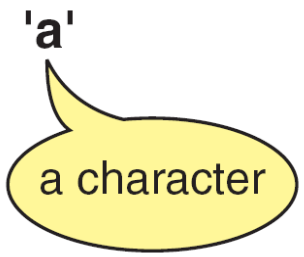


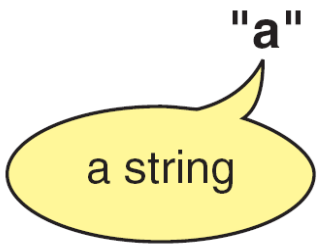


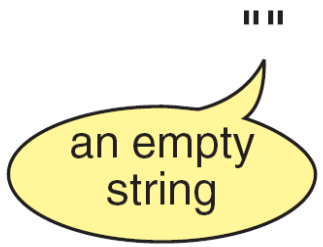






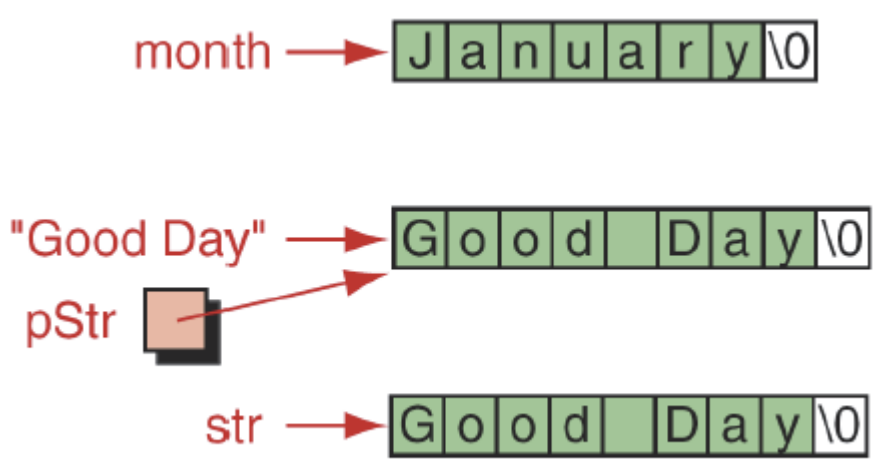






문자열의 선언

- 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’};

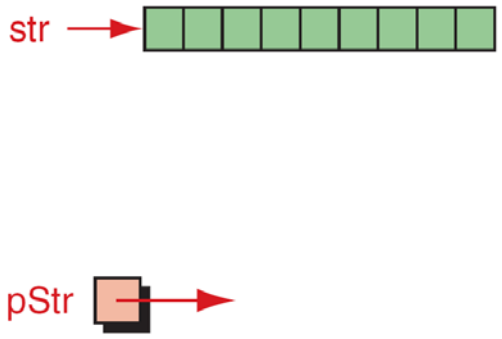



```
// Local Declarations
   char str[9];
```

(a) String Declaration

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

(b) String Pointer Declaration



문자열의 포인터

- 배열의 이름은 첫번째 element의 주소와 같다.
- 그래서 scanf로 %s 받을 때 & 안 붙인다!

문자열 포인터 사용 주의점

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

(a) String Declaration


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

(b) String Pointer Declaration

- 반드시 동적 할당 해주거나 어떤 문자열의 주소를 넣어주어야 한다.

String Copy?

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

String Input/Output Functions

#include ⟨stdio.h⟩

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’)

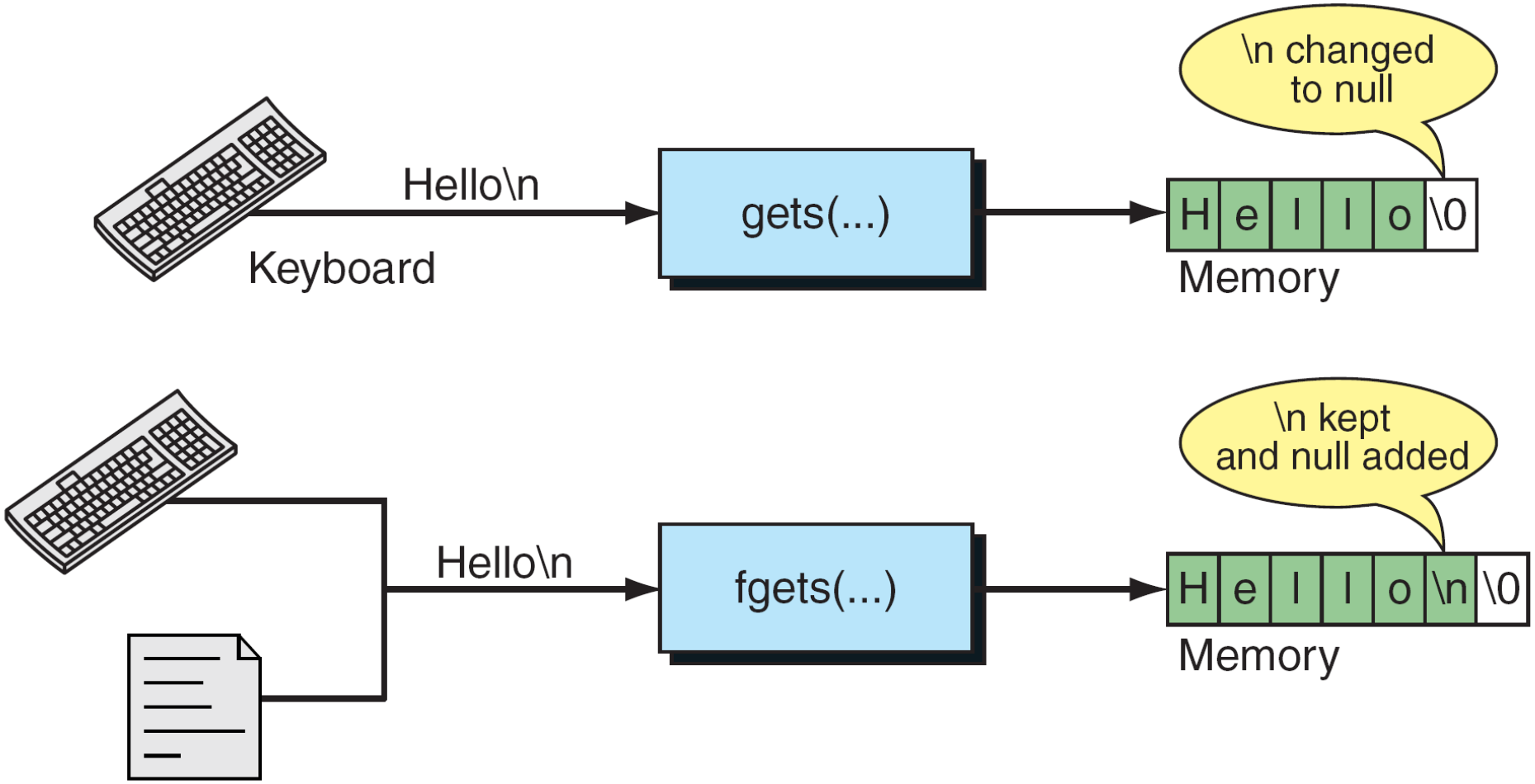
```
1  {  // Read Month
2     #define FLUSH while (getchar() != '\n')
3     char month[10];
4
5     printf("Please enter a month. ");
6     scanf("%9s", month);
7     FLUSH;
8  }  // Read Month
```

Formatted String Input

- char str[10];
- scanf(“%9s”, str);
- str – 배열 포인터 → &가 붙지 않음

- 입력 문자 개수를 반드시 정의해 주자

String-only Input: gets/fgets



gets(…)

char * gets(char *str);

Reads characters from stdin, until either a newline or EOF

Params

- str: pointer to an array of chars

→ 길이 제한 없음 (보안상 취약)

Return value

- Success: returns str (incl. ‘\0’ at the end)
- EOF: feof() set, 여태까지 읽은 str return
- 아무것도 못 읽으면: NULL

fgets(…)

char * fgets (char *str, int num, FILE *stream);

Reads characters from stream, until (num-1) characters have been read OR either a newline or the EOF

Params

- str : pointer to an array of chars
- num : Maximum number of characters (incl. null) → 문자는 최대 (num-1)
- stream : Pointer to a FILE that identifies an input stream

Return value

- Success: returns str (incl. '\0' at the end)
- EOF: sets EOF(feof), 여태까지 읽은 str 리턴
- 아무것도 못 읽으면: NULL

Difference btw. Input functions

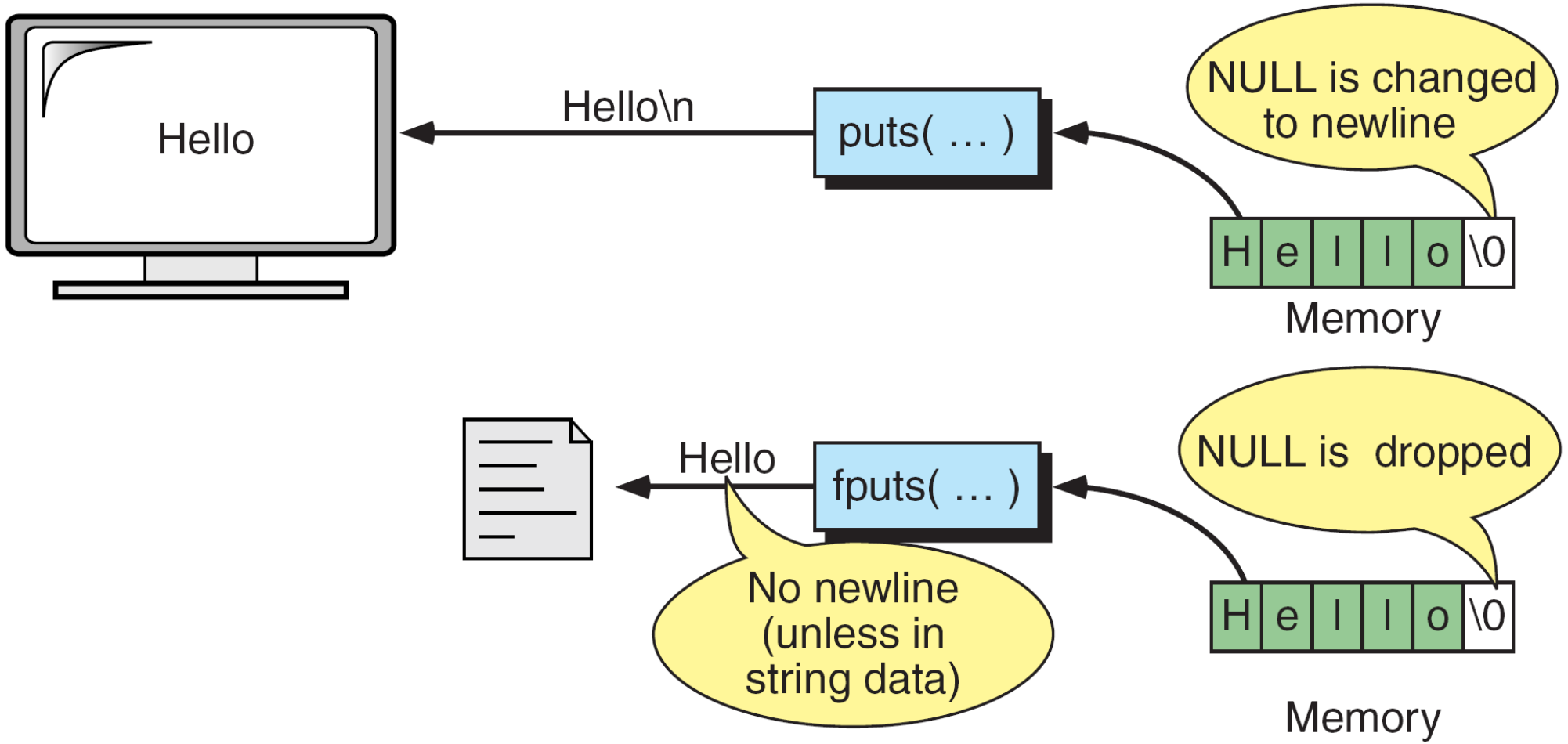
gets/fgets

- gets does not include newline (‘\n’), fgets does.
- gets does not allow to specify a maximum size for *str* (which can lead to buffer overflows).

Scanf/gets

- scanf는 단어 단위로(space), gets는 줄 단위로(newline)

String-only Output: puts/fputs



puts(…)

int puts (const char * str);

Writes str to stdout and appends a newline character ('\n') until null(‘0\’).
Terminating null-character is not copied to the stream.

Params

- str: pointer to an array of chars

Return value

- Success: returns a non-negative value
- Error: returns EOF(-1) and sets the error indicator (ferror)

fputs(…)

```
int fputs ( const char * str, FILE * stream );
```

Writes *str* to the stream until null ('\0'). Terminating null-character is not copied to the stream.

Params

- str: pointer to an array of chars
- stream: Pointer to a FILE object that identifies an output stream.

Return value

- Success: returns a non-negative value
- Error: returns EOF(-1) and sets the error indicator (ferror)

Difference btw. Output functions

- puts appends a newline(‘\n) at the end automatically
- fputs does not write additional characters

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

String Length

unsigned int strlen (const char * str);

Returns the length of the C string *str*, until null('\0').

Params

- str: pointer to an array of chars

Return value

- The length of string.

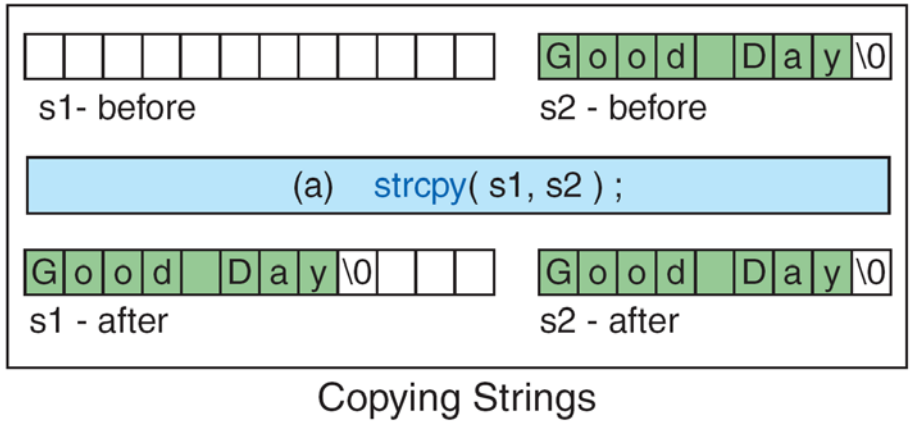
Example

- char mystr[100]="test string";

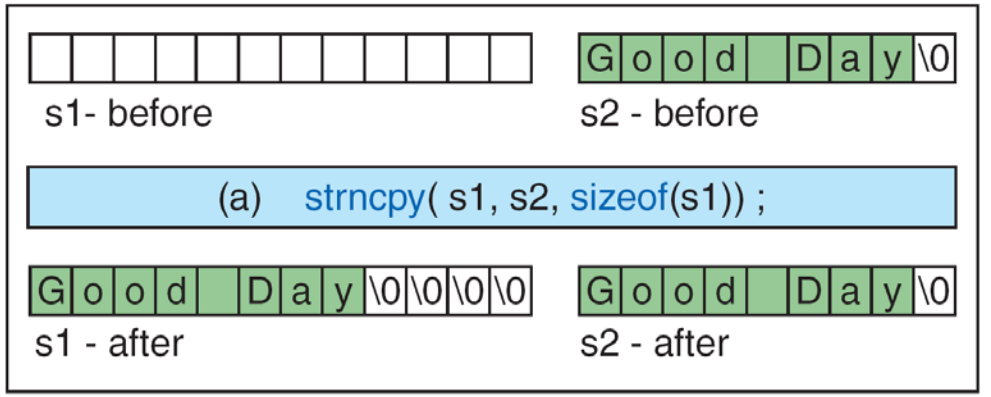
- sizeof(mystr) evaluates to 100
- strlen(mystr) returns 11.

String Copy

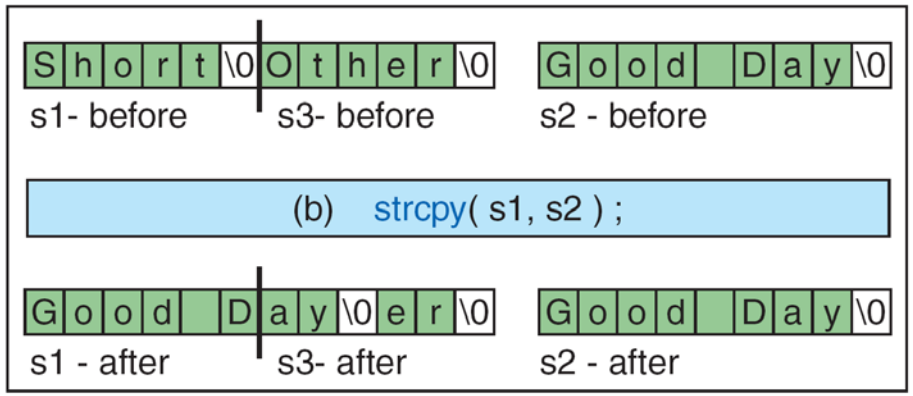
char * strcpy (char * destination, const char * source);
char * strncpy (char * destination, const char * source, unsigned int num);



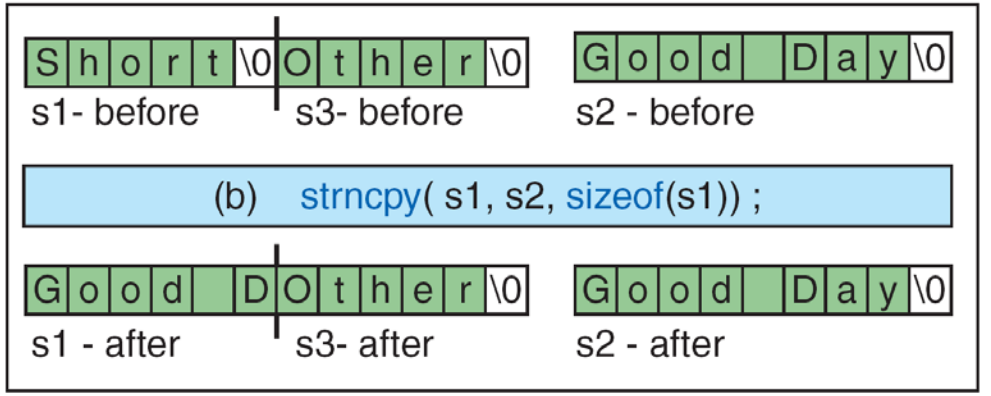
Copying Strings



Copying Strings

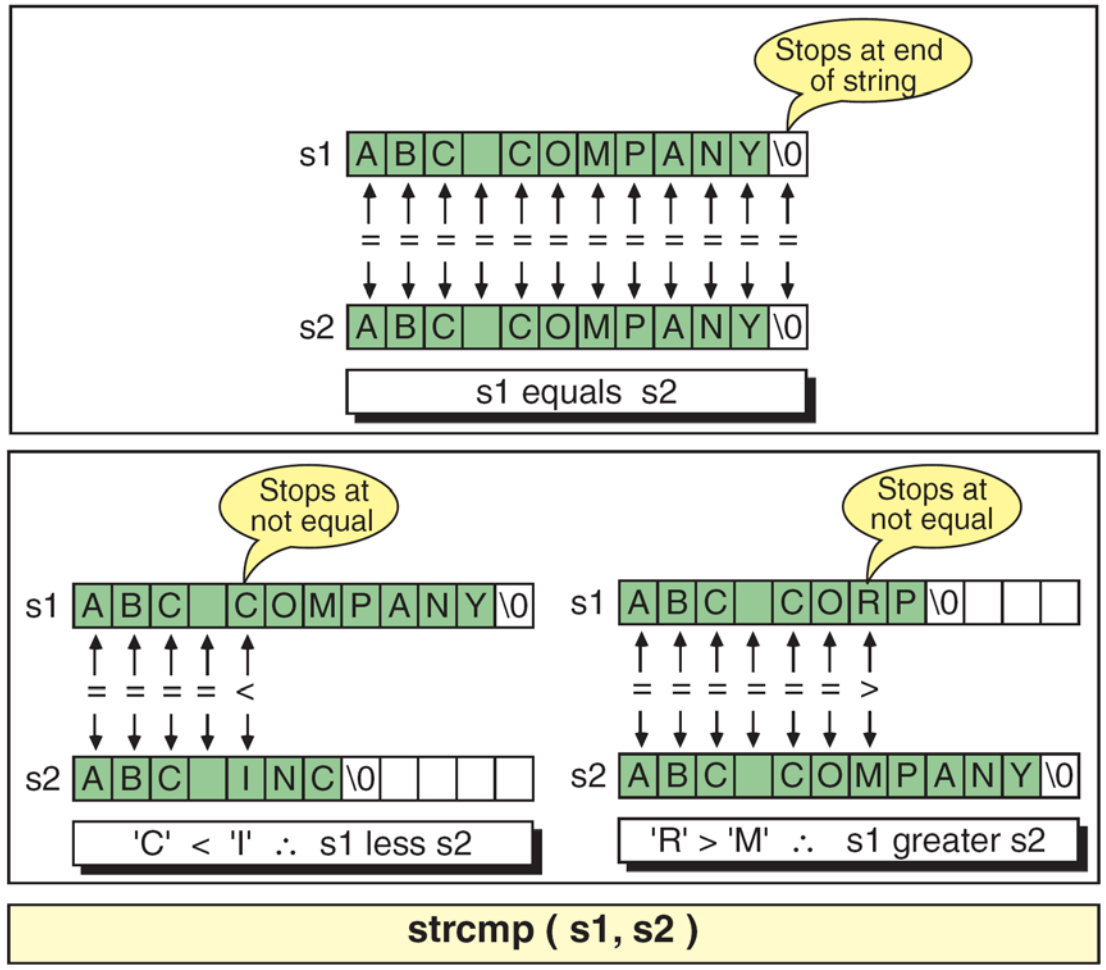


Copying Long Strings



Copying Long Strings

String Compare



int strcmp (const char * str1, const char * str2);
int strncmp(const char * str1, const char * str2, int size);

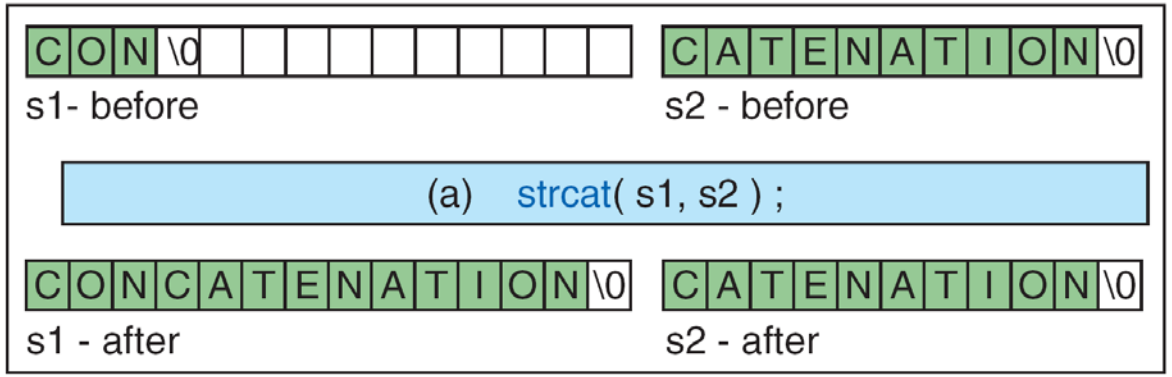
Results for String Compare

- 문자 비교 – 아스키 코드 순으로

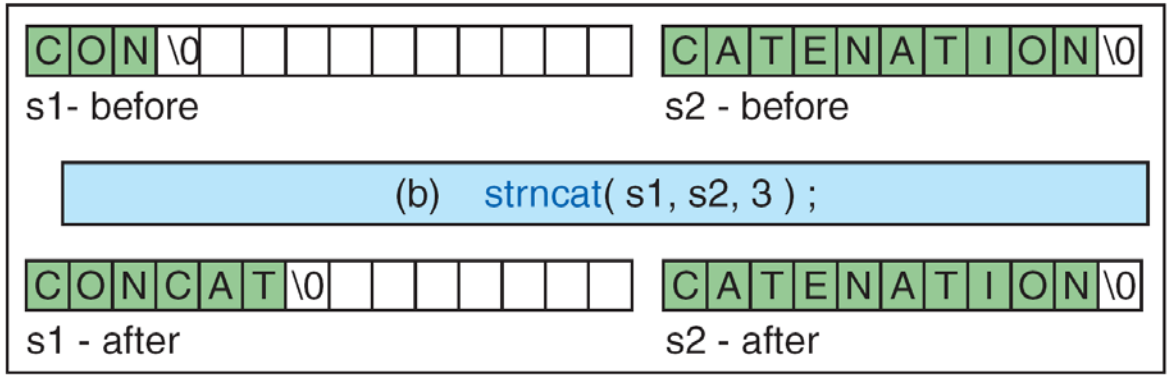
string1	string2	Size	Results	Returns
"ABC123"	"ABC123"	8	equal	0
"ABC123"	"ABC456"	3	equal	0
"ABC123"	"ABC456"	4	string1 < string2	< 0
"ABC123"	"ABC"	3	equal	0
"ABC123"	"ABC"	4	string1 > string2	> 0
"ABC"	"ABC123"	3	equal	0
"ABC123"	"123ABC"	–1	equal	0

String Concatenation

char * strcat (char * destination, const char * source);
char * strncat (char * destination, const char * source, unsigned int num);



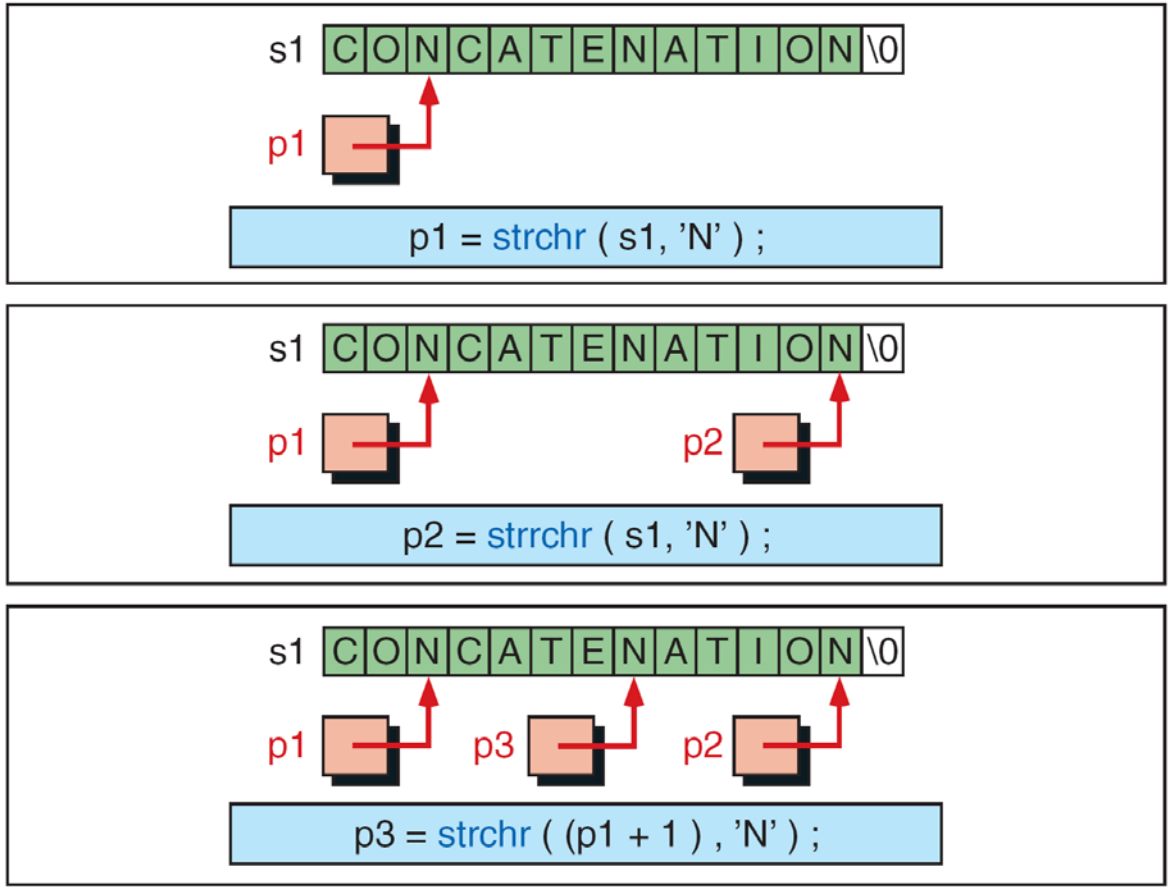
String Concatenate



String N Concatenate

Character in String

char * strchr (const char * str, int character);



Return Value
A pointer to the first occurrence of *character* in *str*.

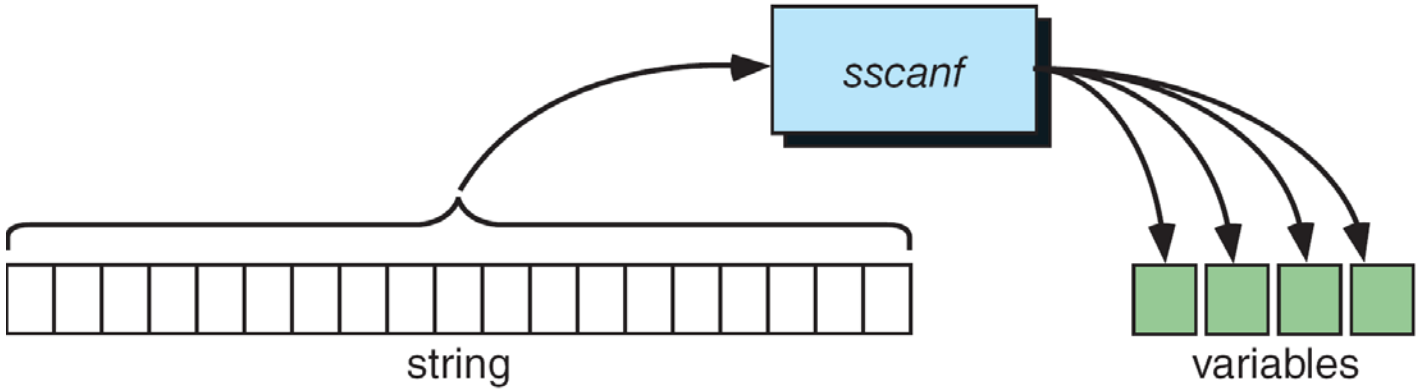
If the *character* is not found, the function returns a null pointer.

String/Data Conversion

- #include ⟨stdio.h⟩

- String to Data Conversion
- Data to String Conversion

sscanf(…)



Read formatted data from string

- sscanf is a one–to–many function.
- It splits one string into many variables.

sscanf (…)

int sscanf (const char *str, const char *format, …);

Reads data from *str* and stores them according to parameter *format* into the locations given by the additional arguments

- scanf – stdin/ sscanf – str

Params

- str: Pointer to source char arrays
- format: Pointer to a format string
- … (additional arguments): Sequence of additional arguments depending on the format string with the appropri ate type. Additional arguments are ignored.

Return value

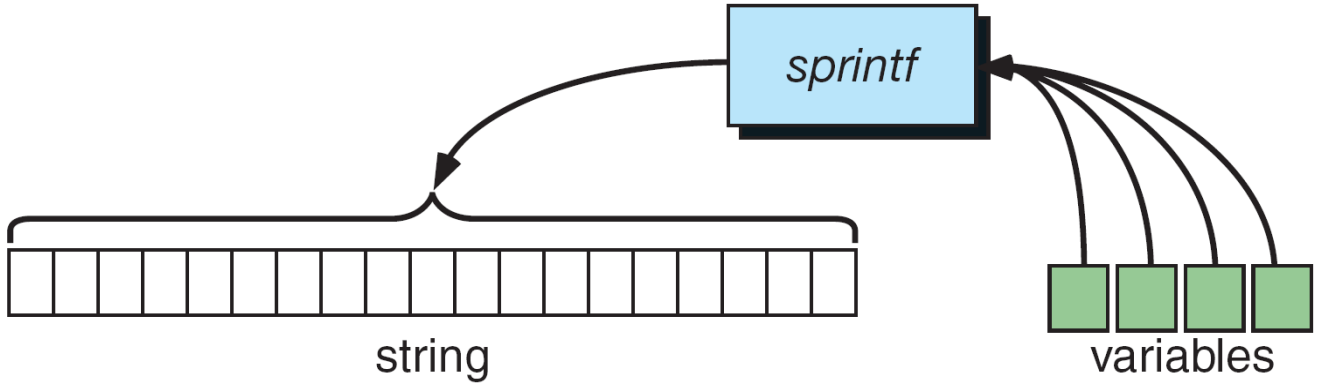
- Success: returns the number of items in the argument list successfully filled.
- Failure: EOF(−1) is returned.

Example

```
#include <stdio.h>

int main ()
{
  char sentence []="Rudolph is 12 years old";
  char str [20];
  int i;

  sscanf (sentence,"%s %*s %d",str,&i);
  printf ("%s -> %d\n",str,i);

  return 0;
}
```

Output:
Rudolph -> 12

sprintf(…)



Write formatted data to string

- sprintf is a many–to–one function.
- It joins many pieces of data into one string.

sprintf (…)

int sprintf (char * str, const char * format, ...);

Composes a string and stores it as a C string in the buffer pointed by *str* according to the *format.*

- printf – stdout, sprint – str
- A terminating null character('\0') is automatically appended after the content.

Parameters

- str: Pointer to a buffer where the resulting C–string is stored.

The size of the buffer should be large enough to contain the entire resulting string (snprintf for a safer version).

- format: C string that contains a format string
- … (additional arguments): a sequence of additional arguments, depending on the format string. Additional arguments are ignored.

Return value

- Success: the total number of characters written is returned. (w/o null–character)
- Failure: a negative number is returned.

Example

```
#include ⟨stdio.h⟩

int main ()
{
  char buffer [50];
  int n, a=5, b=3;
  n = sprintf (buffer, "%d plus %d is %d", a, b, a+b);
  printf ("[%s] is a string %d chars long\n",buffer,n);
  return 0;
}
```

Output:
[5 plus 3 is 8] is a string 13 chars long

More at

- http://www.cplusplus.com/reference/string/

- 수업시간에 한 것들은 한 번씩 찾아 보고 사용법 익히기

Assn #4 – Prob 1: String 처리 함수 구현하기

- int mystrlen(char *str);
- char *mystrcpy(char *toStr, char *fromStr);
- char *mystrcmp(char *str1, char *str2);
- char *mystrcat(char *str1, char *str2);
- char *mystrchr(char *str, char ch);
- int myatoi(char *str); → 이건 저번 어싸인에서 했고

- 위에서 기본적인 원리는 다 했죠? ^^

Assn #4 – Prob 2

- 최소 5개 이상의 함수 작성 – 파일로부터 리스트를 생성하는 부분(1개의 함수)과 각 메뉴(4개의 함수)
- 특정 학생의 정보 및 과목 정보는 구조체의 변수에 저장, 프로그램 내부에서 동적 할당된 구조체 포인터의 배열을 이용하여 관리 = 필요할 때 마다 동적 할당 해서 쓰세요
- C:\> assn4.exe students.txt

→ Argument Passing – int main(int argc, char* args[])

- 예외 처리 – 파일 읽기에서 읽을 파일이 존재하지 않을 경우: fopen의 “r” 모드 리턴 값 NULL
- 파일 읽기 – fgets가 NULL을 리턴할 때까지(EOF)

Assn #4 – Prob 2

```
typedef struct {
    int id;
    char name[11];
    char dept[7];
    int level;
    int sub_num;
    TAKING_SUBJECTS
    subjects[MAX_TAKING_SUBJECT_NUM];
} STUDENT;

STUDENT* stu_list[MAX_STUDENT_NUM];
SUBJECT* sub_list[MAX_SUBJECT_NUM];
```

1. 학생 별 성적

stu_list 한번 돌면서 STUDENT 안에 subjects 배열 한번 돌고

2. 과목 별 성적

학생 명단을 출력하는 게 좀 짜증나는데, 역시 stu_list 돌면서 subjects 배열에 해당 과목이 있으면 출력해 주면 되겠죠~

3. 저장하기

For 문으로 배열 돌면서 주어진 틀에 맞춰서 fputs 만 잘 써주면 되겠네요~

다음시간

- 어싸인 너무 쉽다
- Various Data Structures implemented with Lists