

Strings

- A *string* is a combination of characters. We have been using strings in our output statements to display messages, and format strings in our input and output statements.

Example:

```
printf("File can not be opened!\n");  
fscanf(grd_file, "%d %lf", &id, &grd);
```

- In fact, a string is nothing but a character array. Each element of that array contains only one character.
- The C language uses `\0` (NULL character) to mark the end of a string.
- We can initialize a character array to a string during its declaration.

Example:

```
char name[5] = "Ali";
```

- As a result of the above statement, the C language will put the `\0` character in the 4th element (with index 3), therefore warning itself that the rest of the array is not used.

| | | | | | |
|------|---|---|---|----|---|
| name | A | I | i | \0 | ? |
|------|---|---|---|----|---|

string

- String handling functions ignore whatever is stored in the cells following the null character.
- As you know, We can also initialize the `name` array as

```
char name[5] = {'A', 'I', 'i'};
```

- What is the difference between them?

| | | | | | |
|------|---|---|---|---|---|
| name | A | I | i | ? | ? |
|------|---|---|---|---|---|

array of characters

- So, the longest string the `name` array above can represent is 4 characters plus the NULL character. But, you can store 5 characters in it using the second way.

```
char name[5] = "Aliye"; // COMPILATION ERROR!  
char name[5] = {'A', 'I', 'i', 'y', 'e'}; // NO PROBLEM
```

- Since a string is a character array, you can refer to its individual elements as you did with other arrays. For example:

```
printf ("%c\n", name[0]);
```

will output the character **A**.

- A string may also consist of a single character. For instance, the difference of writing `'a'` and `"a"` within a program is that the first one is a character and can be put into a one-byte character variable. The second one is a string and can not be put into a one-byte character variable. It can be put into a character array with the minimum size 2, because the computer stores the NULL character at the end of it.

```
char ch = 'a';
char ch = "a"; // COMPILATION ERROR
char ch[2] = "a";
```

Example: Write a function that finds the length of a string.

```
int str_length(char str[])
{
    int k = 0;
    // Go until the end of the string
    while (str[k] != '\0')
        k++;
    return (k);
}
```

Example: Write a function that finds the length of a string using pointers.

```
int str_length(char *str)
{
    char *p = str;
    // Go until the end of the string
    while (*p != '\0')
        p++;
    return (p - str);
}
```

- We can call the above function as follows:

```
char str[20] = "Example";
printf("length = %d\n", str_length(str));
```

What will be the output?

- Since one string is an array of characters, an array of strings is a two-dimensional array of characters in which each row is one string.

Example:

```
char week[7][10] = {"monday", "tuesday", "wednesday",
                    "thursday", "friday", "saturday", "sunday"};
```

| | | | | | | | | | |
|---|---|---|---|---|---|----|----|----|----|
| m | o | n | d | a | y | \0 | | | |
| t | u | e | s | d | a | y | \0 | | |
| w | e | d | n | e | s | d | a | y | \0 |
| t | h | u | r | s | d | a | y | \0 | |
| f | r | i | d | a | y | \0 | | | |
| s | a | t | u | r | d | a | y | \0 | |
| s | u | n | d | a | y | \0 | | | |

```
printf("%c\n", week[2][0]);
```

will output the character **w**.

Input/Output of Strings

- Upto now we used loops to input or output character arrays. The C programming language can input or output the whole string using the **%s** placeholder.

Example:

```
printf("%s\n", week[1]);
```

will output the string **tuesday**. What about

```
printf("%s\n", week);
```

It will output the string **monday**.

```
printf("%s\n", *week);
```

will also output the string **monday**.

- `printf` displays the characters in the string until NULL character is encountered. NULL character is automatically put in the constant strings.
- If no NULL character is found in the character array, `printf` would continue to print as many characters as it can find in the following memory locations until it finds a NULL character or until a run-time error is caused.

Example: What will be output for the following code segment?

```
char name1[5] = "Esin";
printf("%s\n", name1);
char name2[5] = {'D', 'e', 'n', 'i', 'z'};
printf("%s\n", name2);
```

- What about

```
printf("%s\n", name1+2);
```

- What about

```
printf("%c\n", *name1);
printf("%c\n", *(name1+2));
```

- We can format our string output using an integer between % and s in the %s placeholder. If that integer is positive, the string is right-justified (the left side of it stays blank). If it is negative, the string is left-justified (the right side of it stays blank). If it is smaller than the length of the string, the full string is displayed (with no blanks on the left or right side).

Example:

```
printf("***%10s***%-8s***%3s***\n", week[6], week[0], week[4]);
```

will output ***_ _ _ _sunday***monday_ _***friday***.

- When we use %s as a placeholder in scanf, it stops scanning whenever a white space character (blank, newline or tab) is encountered.

Example:

```
char std_name[20];
scanf("%s", std_name);
```

If the input is **Ekin Kara**, only **Ekin** will be stored into std_name.

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|----|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | k | i | n | \0 | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |
|---|---|---|---|----|---|---|---|---|---|---|---|---|---|---|---|---|---|

- Notice that, in scanf we did not put & in front of the variable name, because the name of an array represents the address of its starting position.

- A string can be input using a *scan set* or an *inverted scan set*. The *scan set* stops inputting characters when a character not contained in the scan set is encountered.

Scan Set:

```
%[a-z]           : input only lowercase letters
%[0-9]           : input only digits
%[a-zA-Z]        : input both lowercase and uppercase letters
%[aeiouAEIOU]    : input only vowels
```

- The *inverted scan set* causes the characters not appearing in the scan set to be stored until a character contained in the inverted scan set is encountered.

Inverted Scan Set:

```
%[^0-9]          : input anything that is not a digit
%[^aeiouAEIOU]    : input everything until a vowel
%[^\n]            : input everything until a newline
```

Example:

```
char str1[10], str2[10], str3[10], str4[10];
printf("Enter a string: ");
scanf("%[0-9]%[a-z]%[^a-z]%[^\n]", str1, str2, str3, str4);
printf("***%s***%s***%s***%s***\n", str1, str2, str3, str4);
```

Output:

```
Enter a string: 10years AGO here
***10***years*** AGO ***here***
```

- You can include any character in the inverted scan set to indicate the end point of the input of a string.

Example:

```
char str[50];
printf("Enter a string (finish with a question mark): ");
scanf("%[^?]", str);
```

➤ *READ (pg 369 – 370) from Deitel & Deitel.*

- Remember that we could input and output a single character with `getchar` and `putchar` functions. C language provides functions for also input and output of strings: `gets` and `puts`.

```
char *gets(char *s)
int puts(const char *s)
```

- The **gets** function gets a string from the keyboard (until a newline or end-of-file character is encountered) and stores it into a character array and returns a pointer to that array. A terminating NULL character is appended to the array.
- The **puts** function prints a string followed by a newline character.

Example:

```
char line[80];
char *line_ptr;
printf("Type in a line of data:\n");
line_ptr = gets(line);    // scanf("%[^\\n]", line);
                           // line_ptr = line;
puts(line);               // printf("%s\\n", line);
puts(line_ptr);           // printf("%s\\n", line_ptr);
```

Output:

```
Type in a line of data:
This is the sample sentence.
This is the sample sentence.
This is the sample sentence.
```

Example: Write a program to count the characters and the words in the input until a newline character is entered.

```

#include <stdio.h>
#define NL      '\n'
#define BLANK  ' '
#define NO      0
#define YES     1

int main(void) {
    int  nc = 0,      // (output) no. of chars
        nw = 0;      // (output) no. of words
    char ch;          // (input) a character of the line
    int  flag;        /* to test whether we are currently in a word
                        or not */

    flag = NO;        // not in the word
    printf("Type in a line of data:\n");
    ch = getchar();    // gets char from the standard input stream
    // Repeat until the end of the line
    while (ch != NL) {
        nc++; // increment number of characters
        if (ch == BLANK) // Skip all the blanks
            flag = NO;
        else if (flag == NO) { // If it is the first letter of
            flag = YES;        // a word in the word
            nw++; // increment number of words
        }
        ch = getchar(); // Get the next character
    }

    // Display number of characters and words
    printf("Characters: %d\nWords: %d\n", nc, nw);

    return (0);
}

```

- The variable `flag` is used to test whether we are currently in a word or not.
- Notice that the above program works even if there are more than one blanks between the words, and even if the first word is preceeded with some blanks.

Character Handling Library

- The character handling library with the header file **<ctype.h>** includes several functions that perform useful tests and manipulations of character data. Each function receives a character represented as a one-byte integer.
- The following functions are boolean functions. Thus, they return a true (nonzero) value if the condition checked is true, otherwise return 0.

```
int islower(int c)      // Is c a lowercase letter?
int isupper(int c)      // Is c an uppercase letter?
int isalpha(int c)      // Is c a letter?
int isalnum(int c)      // Is c a digit or a letter?
int isdigit(int c)      // Is c a decimal digit (0 – 9)?
int isxdigit(int c)     // Is c a hexadecimal digit (0 – F)?
int isspace(int c)      // Is c a whitespace character (space, newline, tab, form feed)?
int iscntrl(int c)      // Is c a control character?
int isprint(int c)      // Is c a printing character (including space)?
int isgraph(int c)      // Is c a printing character (other than space)?
int ispunct(int c)      // Is c a printing character (other than a letter, digit and whitespace)?
```

- As you know, the following functions converts a character to lowercase or uppercase.

```
int tolower(int c)      // converts c to lowercase if appropriate
int toupper(int c)      // converts c to uppercase if appropriate
```

➤ *READ Sec. 8.3 (pg 309 – 314) from Deitel & Deitel.*