Strings and One-Dimensional Character Arrays

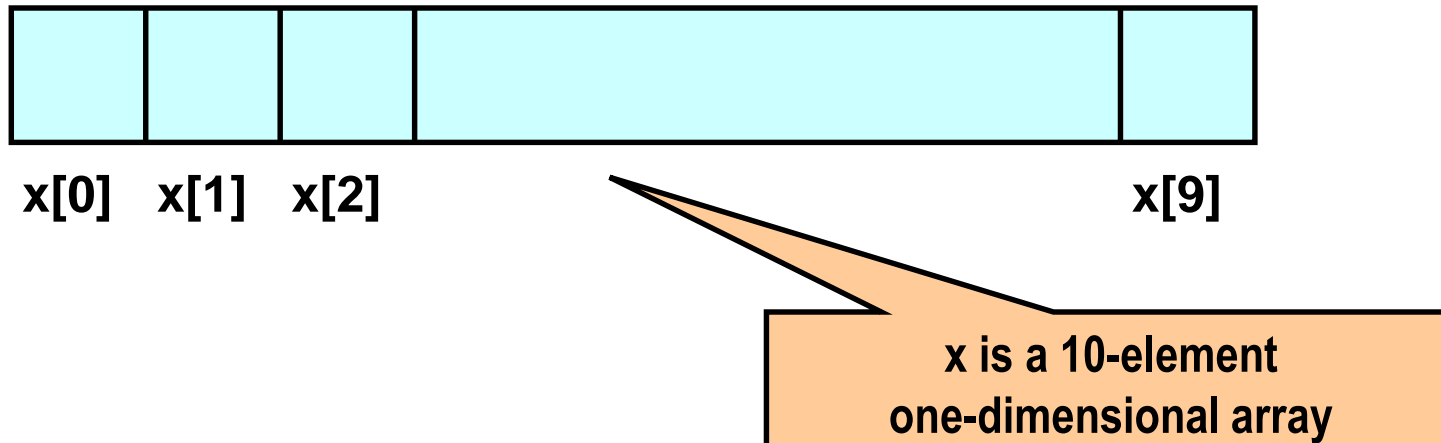## CS10003 PROGRAMMING AND DATA STRUCTURES

Recap: integer arrays

All the data items constituting the group share the same name

```
int  x[10];
```

Individual elements are accessed by specifying the index

x[0]   x[1]   x[2]   x[9]

x is a 10-element
one-dimensional array

Can initialize an array during declaration:

```
int x[5] = {76, 99, 0, -3, 8};
```

Character Arrays and Strings

```
char C[8] = {'p', 'r', 'o', 'g', 'r', 'a', 'm', '\0'};
```

C[0] gets the value 'p', C[1] the value 'r', and so on. The last (7th) location receives the **NULL** character '\0'.

Null-terminated (last character is '\0') character arrays are also called null-terminated strings or just strings.

Strings can be initialized in an alternative way. The last declaration is equivalent to:

```
char C[8] = "program";
```

C automatically puts the trailing null character at the end if you define a string like this.

You can have a bigger array (like c[10] or c[100]) to store the string "program". The *string* ends as soon as the first null character in the *array* is encountered.

The size of the array should be at least one more than the length of the string it stores.

For individual characters, C uses single quotes, whereas for strings, it uses double quotes.

String literals

String literal values are represented by sequences of characters between double quotes.

Examples

- "" represents the empty string
- "hello"

"a" versus 'a'

- 'a' is a single character value (stored in 1 byte) as the ASCII value for the letter a
- "a" is an array with two characters, the first is 'a', the second is the character value '\0'

Reading strings: %s format

```
int main()
{
    char name[25];
    scanf("%s", name);
    printf("Name = %s \n", name);
    return 0;

}
```

%s reads a string into a character array given the array name or start address.

It ends the string with the special "null" character '\0'.

scanf with %s can read a string without any whitespace (blank, tab, linebreak).

Input assumed to end if whitespace is encountered.

Example: Finding the length of a string

```c
#define SIZE 25
int main()
{
    int i, length=0;
    char name[SIZE];
    scanf("%s", name);
    printf("Name = %s\n", name);
    for (i=0; name[i]!='\0'; i++)
                length++;
    printf("Length = %d\n", length);
    return 0;
}
```

Output

Satyanarayana

Name = Satyanarayana

Length = 13

Note that character strings read
in the %s format end with '\0'

Example: Counting the number of a's

```c
#define SIZE 25
int main()
{
  int i, count=0;
  char name[SIZE];
  scanf("%s", name);
  printf("Name = %s \n", name);
  for (i=0; name[i]!='\0'; i++)
      if (name[i] == 'a') count++;
  printf("Total a's = %d\n", count);
  return 0;
}
```

Output

> Satyanarayana
> Name = Satyanarayana
> Total a's = 6

Note that character strings read
in %s format end with '\0'

Example: Palindrome Checking

```c
int main()
{
    int i, flag, len = 0;
    char name[25];
    scanf ("%s", name);              /* Read Name */
    len = 0; while (name[len]) len++;    /* Find Length of String */
    flag = 0;
    /* Loop below checks for palindrome  by comparison*/
    for (i = 0; i < len; i++) {
            if (name[i] != name[len-1-i]) flag = 1;
    }
    if (flag == 0) printf ("%s is a Palindrome\n", name);
    else printf ("%s is NOT a Palindrome\n", name);
    return 0;
}
```

Counting Vowels of a String

```c
#include<stdio.h>
int main()
{
    char A[100], B[5] ={'a', 'e', 'i', 'o', 'u'};
    int i, j, len, C[5]= {0,0,0,0,0};
    scanf ("%s", A);
    printf ("A = %s\n", A);
    for (len = 0; A[len] != '\0'; len++);
    printf ("Length = %d\n", len);
    for (i=0; i<len; i++){
        for (j=0; j<5; j++) {
            if(A[i] == B[j]) C[j]++;
        }
    }
    for (j=0; j<5; j++)
        printf ("Number of %c = %d \n", B[j], C[j]);
}
```

thequickbrownfoxjumpsoverthelazydog
A = thequickbrownfoxjumpsoverthelazydog
Length = 35
Number of a = 1
Number of e = 3
Number of i = 1
Number of o = 4
Number of u = 2

Reading Strings with Blanks

In many applications, we need to read in an entire line of text (including blank spaces).

But scanf with %s cannot input a string having whitespace within it.

One way to enter a string having whitespace within it:

```
char line[101], ch;
int  c = 0;
:
:
do
{
    ch = getchar();
    line[c] = ch;
    c++;
}
while (ch != '\n');

c = c - 1;
line[c] = '\0';
```

Read characters until CR ('\n') is encountered

Make it a valid string

If the input contains more than 100 characters, this program corrupts memory.

To avoid this, keep a counter of how many characters you read. As soon as the count reaches 100, stop reading.

Exercise: Write this safe code.

A built-in function that does (almost) the same thing is fgets().

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Reading Strings with Blanks: Alternate approach

In many applications, we need to read in an entire line of text (including blank spaces).

But scanf with %s cannot input a string having whitespace within it

Another way to enter a string having whitespace within it:

```
char line[81];
    :
    :
scanf ("%[^\n]", line);
```

Reads a string containing any characters until a newline character is received

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Pattern Matching

```c
#include<stdio.h>
int main()
{
    char S[20], P[20];
    int i, j, k, flag;
    printf ("Enter String and Pattern:\n");
    scanf ("%s%s", S, P);
    printf ("S = %s, P = %s \n", S, P);
    k = 0;
    for (i=0; S[i] != '\0'; i++) {
        flag = 1;
        for (j=0; P[j]!='\0'; j++)
            if (S[i+j]!= P[j]) {flag = 0; break;}
        if (flag == 1) k++;
    }
    printf("Number of Matches = %d \n", k);
}
```

Enter String and Pattern:
abababababab
aba
S = abababababab, P = aba
Number of Matches = 5

Enter String and Pattern:
abababababab
ababab
S = abababababab, P = ababab
Number of Matches = 4

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String library functions

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Library Functions

- **Set of functions already written for you, and bundled in a "library"**

  - **Example: printf, scanf, getchar**

- **C library provides a large number of functions for many things**

- **Already seen math library functions earlier**

- **Will look at string library functions**

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String Library Functions

String library functions

- **Perform common operations on null terminated strings.**
- **Must include a special header file:**

        #include <string.h>

Note:

We have discussed: When an integer / float array is sent to a function as an argument, it is required to send an indicator of the size or number of valid elements in the array as another argument.

When a string is sent to a function as an argument, no need to send any separate indicator of the size, since the function can utilize the '\0' to identify the end of the string.

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Common string library functions

strlen – returns the length of a string

strcmp – compares two strings (lexicographic)

strcat – concatenates two strings

strcpy – copy one string to another

Many others, but these are the ones you would know in this course.

These functions need the inputs to be null-terminated. They also put the null character at the end of the result string (provided that the result is a string).

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strcpy()

Works very much like a string assignment operator.

```
strcpy (str1, str2);
```

- Assigns the contents of **str2** to **str1**.
- Returns address of the destination string.

Examples:

```
strcpy(city, "Calcutta");
strcpy(city, mycity);
```

Warning:

- Assignment operator does not work for strings.

```
city = "Calcutta";  → INVALID
```

strlen()

Counts and returns the number of characters in a string (excluding the null character at the end).

```
int strlen(str);
```

Example:

```
len = strlen(str);
                /* str should be null-terminated. Returns an integer */
```

- The null character ('\0') at the end is not counted.
- Counting ends at the first null character.

strcmp()

Compares two character strings (lexicographic comparison).

```
int strcmp(str1, str2);
```

- **Returns 0 if the two strings are equal, < 0 if the first string is lexicographically smaller than the second string, > 0 if the first string is lexicographically larger than the second string.**

- **20 > 9 as integers, "20" < "9" as strings.**

Examples:

```
if (strcmp(city, "Delhi") == 0) printf("The city is Delhi\n");
if (!strcmp(city, "Delhi")) printf("The city is Delhi\n");
if (strcmp(city1, city2))
    printf("%s and %s are different cities\n", city1, city2);
```

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Example

```
int main()
{
    char A[20], B[20];
    int n, m, val;
    scanf("%s%s", A, B);
    n = strlen(A);
    m = strlen(B);
    printf("The lengths of the strings are %d and %d\n", n, m);
    val = strcmp(A, B);
    if (val == 0)
                printf("The strings are the same\n");
    else if (val < 0)
                printf("%s is smaller than %s\n", A, B);
    else
                printf("%s is smaller than %s\n", A, B);
}
```

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strcat()

Joins or concatenates two strings together

```
strcat(str1, str2);
```

- **str2** is appended to the end of **str1**.
- The **null character** at the end of **str1** is removed, and **str2** is joined at that point.
- **str1** should have enough space -- Programmer's responsibility

Example:

```
strcpy(name1, "Amit ");
strcpy(name2, "Roy");
strcat(name1, name2);
```

A	m	i	t		\0			

R	o	y	\0

A	m	i	t		R	o	y	\0

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