Strings and One-Dimensional Character Arrays

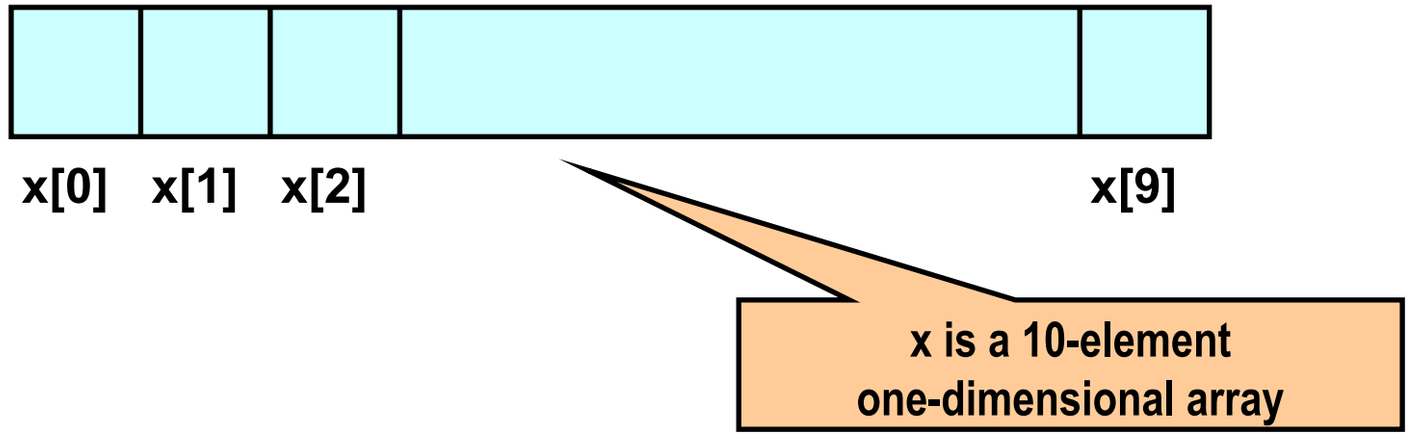
CS10003 PROGRAMMING AND DATA STRUCTURES

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



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

```
#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

```
#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

```
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

```
#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().

Pattern Matching

```
#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

String library functions

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

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.

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).

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).

```
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).

```
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);
```

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);
}
```

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);
```