Character String

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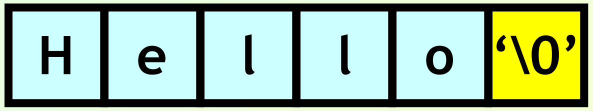
What we should learn about strings

- Representation in C
- String Literals
- String Variables
- String Input/Output
  - printf, scanf, gets, fgets, puts, fputs
- String Functions
  - strlen, strcpy, strncpy, strcmp, strncmp, strcat, strncat, strchr, strrchr, strstr, strspn, strcspn, strtok
- Reading from/Printing to Strings
  - sprintf, sscanf

Introduction

- A string is an array of characters.
  - Individual characters are stored in memory in ASCII code.
  - A string is represented as a sequence of characters terminated by the null ('\0') character.

"Hello" →



String Literals

- String literal values are represented by sequences of characters between double quotes (“)

- Examples
  - [?]"" represents 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.

Referring to String Literals

- String literal is an array, can refer to a single character from the literal as a character

- Example:

```
printf("%c", "hello"[1]);
```

outputs the character ‘e’

- During compilation, C creates space for each string literal (number of characters in the literal + 1)

Duplicate String Literals

- Each string literal in a C program is stored at a different location.
  - Even if the string literals contain the same string, they are not equal (in the == sense)
- Example:

```
 char string1[6] = "hello";
char string2[6] = "hello";
```

  - but `string1` does not equal `string2` (they are stored in different memory locations).

Declaring String Variables

- A string is declared like any other array:

```
        char string-name[size];
```

  - size determines the number of characters in string_name.

- When a character string is assigned to a character array, it automatically appends the null character (‘\0’) at the end of the string.
  - size should be equal to the number of characters in the string plus one.

Examples

```
char   name[30];
char   city[15];
char   dob[11];
```

- A string may be initialized at the time of declaration.

Equivalent

```
char    city[15] = "Calcutta";
char    city[15] = {'C', 'a', 'l', 'c', 'u',
                    't', 't', 'a', '\0'};
char    dob[] = "12-10-1975";
```

Changing String Variables

- Cannot change string variables connected to string constants, but can change pointer variables that are not tied to space.

- Example:

```
char *str1 = "hello";        /* str1 unchangeable */
char *str2 = "goodbye";      /* str2 unchangeable */

char *str3;  /* Not tied to space */
str3 = str1; /* str3 points to same space as str1 */
str3 = str2;
```

Changing String Variables (cont)

- Can change parts of a string variable:

```
char str1[6] = ″hello″;
str1[0] = 'y';        /* str1 is now "yello" */
str1[4] = '\0';       /* str1 is now "yell" */
```

- Have to stay within limits of the array.
  - Responsibility of programmer.

Reading Strings from the Keyboard

- Two different cases will be considered:
  - Reading words
  - Reading an entire line

Reading "words"

- scanf can be used with the "%s" format specifier.

```
char    name[30];
:
scanf ("%s", name);
```

  - The ampersand (&) is not required before the variable name with "%s".
    - Because `name` represents an address.
  - The problem here is that the string is taken to be up to the first *white space* (blank, tab, carriage return, etc.)
    - If we type "`Rupak Biswas`"
    - `name` will be assigned the string "`Rupak`"

Reading a “line of text”

- In many applications, we need to read in an entire line of text (including blank spaces).
- We can use the `getchar()` function for the purpose.

```
char   line[81], 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

Reading a line :: Alternate Approach

```
char line[81];
:
:
scanf ("%[ ABCDEFGHIJKLMNOPQRSTUVWXYZ]", line);
```

➔ Reads a string containing uppercase characters and blank spaces

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

➔ Reads a string containing any characters

More on String Input

- Edit set input `%[ListofChars]`
  - ListofChars specifies set of characters (called scan set)
  - Characters read as long as character falls in scan set
  - Stops when first non scan set character encountered
  - Any character may be specified except]
  - Putting ^ at the start to negate the set (any character BUT list is allowed)

- Examples:

```
scanf  ("%[-+0123456789]",  Number);
scanf  ("%[^\n]", Line);    /* read until newline char */
```

Writing Strings to the Screen

- We can use printf with the “%s” format specification.

```
char name[50];
:
:
printf ("\n %s", name);
```

Input / Output Example

```
#include <stdio.h>

void main( )
{
   char LastName[11];
   char FirstName[11];

   printf("Enter your name (last, first): ");
   scanf("%s%s",  LastName,  FirstName);

   printf("Nice to meet you %s %s\n", FirstName, LastName);
}
```

String Functions

Processing Character Strings

- There exists a set of C library functions for character string manipulation.
  - strcpy :: string copy
  - strlen :: string length
  - strcmp :: string comparison
  - strtcat :: string concatenation
- It is required to add the line

```
#include <string.h>
```

strcpy()

- Works like a string assignment operator.

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

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

- Examples:

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

- Warning:
  - Assignment operator do not work for strings.

```
city  = "Calcutta ";
```

$\rightarrow$ INVALID

strlen()

- Counts and returns the number of characters in a string.

```
int strlen (char *str);
```

- Example:

```
len = strlen (string);
```

/* Returns an integer */

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

```
char  city[15];
int  n;
:
:
strcpy (city, "Calcutta");
n = strlen (city);
```

n is assigned 8

strcmp()

- Compares two character strings.

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

  - Compares the two strings and returns 0 if they are identical; non-zero otherwise.
- Examples:

```
if (strcmp(city, "Delhi") == 0)
    {   ......   }

if (strcmp(city1, city2) != 0)
     { ...... }
```

- Actually, the function returns the difference in ASCII values of the first letter of mismatch.
  - Less than 0
    - If the ASCII value of the character they differ at is smaller for str1, or str2 is longer than str1
  - Greater than 0
    - If the ASCII value of the character they differ at is greater for str1, or str1 is longer than str2
  - Equal to 0
    - If the two strings are identical

strcmp examples:

```
strcmp("hello", "hello")         -- returns 0
strcmp("yello", "hello")         -- returns value > 0
strcmp("Hello", "hello")         -- returns value < 0
strcmp("hello", "hello there")   -- returns value < 0
strcmp("some diff", "some dift") -- returns value < 0
```

- Expression for determining if two strings s1, s2 hold the same string value:

```
!strcmp(s1, s2)
```

String Comparison (strncmp)

Sometimes we only want to compare first n chars:

```
int strncmp(char *s1, char *s2, int n)
```

Works the same as strcmp except that it stops at the nth character looks at less than n characters if either string is shorter than n

```
strcmp("some diff", "some DIFF")    -- returns value > 0
strncmp("some diff", "some DIFF",4)  -- returns 0
```

String Comparison (ignoring case)

```
int strcasecmp(char *str1, char *str2)
```

- similar to strcmp except that upper and lower case characters (e.g., ‘a’ and ‘A’) are considered to be equal

```
int strncasecmp(char *str1, char *str2, int n)
```

- version of strncmp that ignores case

strcat()

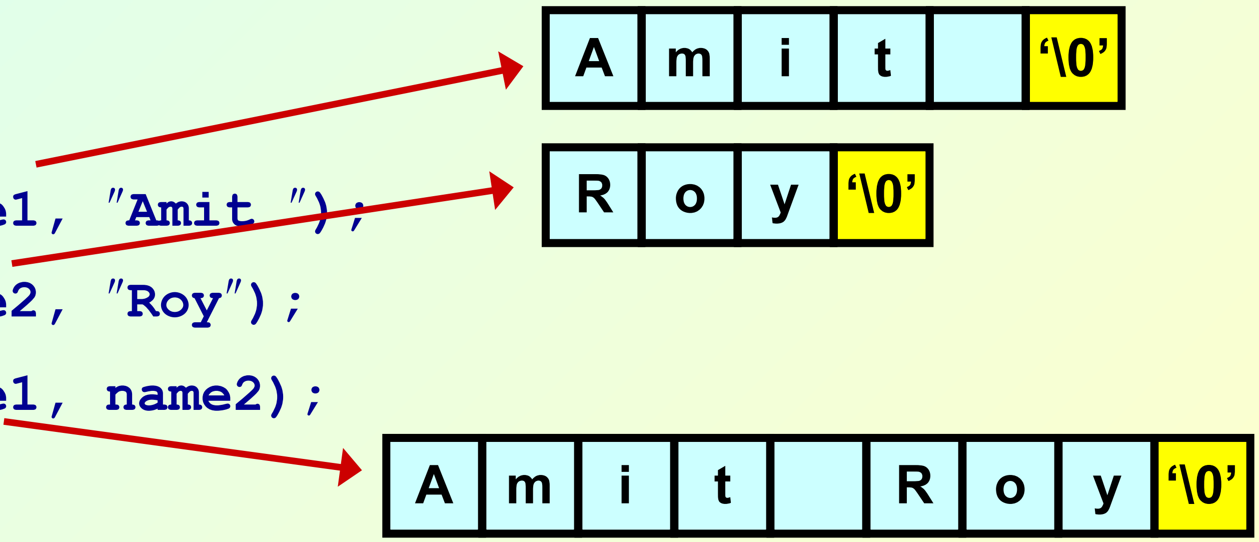
- Joins or concatenates two strings together.

```
char *strcat (char *str1, char *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.

- Example:

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



Example:: count uppercase

```
/* Read a line of text and count the number of
uppercase letters */
#include  <stdio.h>
#include  <string.h>
main()
{
    char  line[81];
    int  i, n, count=0;
    scanf ("%[^\n]", line);
    n = strlen (line);
    for (i=0; i<n; i++)
       if (isupper(line[i])  count++;
    printf ("\n The number of uppercase letters in
the string %s is %d", line, count);
}
```

Example:: compare two strings

Parameters passed as character array

```
#include <stdio.h>

int my_strcmp (char s1[],char s2[])

{
      int i=0;
      while(s1[i]!='\0' && s2[i]!='\0'){
         if (s1[i]!=s2[i]) return(s1[i]-s2[i]);
         else i++;
        }
      return(s1[i]-s2[i]);
}
```

```
main()
{
   char string1[100],string2[100];

   printf("Give two strings \n");
   scanf("%s %s", string1, string2);

   printf ("Comparison result: %d \n",
       my_strcmp(string1,string2));
}
```

```
Give two strings
IITKGP IITMUMBAI
Comparison result: -2
```

```
Give two strings
KOLKATA KOLKATA
Comparison result: 0
```

Searching for a Character/String

char *strchr (char *str, int ch)

- returns a pointer to the first occurrence of ch in str
- returns NULL if ch does not occur in str
- can subtract original pointer from result pointer to determine which character in array

char *strstr (char *str, char *searchstr)

- similar to strchr, but looks for the first occurrence of the string searchstr in str

char *strrchr (char *str, int ch)

- similar to strchr except that the search starts from the end of string str and works backward

Printing to a String

- The sprintf function allows us to print to a string argument using printf formatting rules.
- First argument of sprintf is string to print to, remaining arguments are as in printf.

Example:

```
char buffer[100];
sprintf (buffer, "%s, %s", LastName, FirstName);
if (strlen(buffer) > 15)
    printf("Long name %s %s\n", FirstName, LastName);
```

Reading from a String

- The sscanf function allows us to read from a string argument using scanf rules
- First argument of sscanf is string to read from, remaining arguments are as in scanf

Example:

```
char buffer[100] = "A10 50.0";
sscanf (buffer, "%c%d%f", &ch, &inum, &fnum);
   /* puts 'A' in ch, 10 in inum and 50.0 in fnum */
```

Example: Duplicate Removal

Write a C function that takes a string as an argument and modifies the string so as to remove all consecutive duplicate characters, e.g., mississippi -> misisipi

```
void remove_duplicates (char word[]) {
   int k, j;
   char prev = '\0';
   for (k = j = 0; word[k]!='\0'; k++)  {
    if (prev != word[k]) word[j++] = word[k];
    prev = word[k];
   }
   word[j] = '\0';
}
```