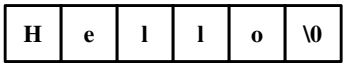
CSC 270 – Survey of Programming Languages

C Lecture 4 – Strings

C-String Values

- The most basic way to represent a string of characters in C++ is using an array of characters that ends with a null byte.
- Example

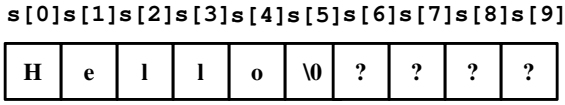
```
printf("Hello");
```



C-String Variables

- A C-string variable is an array of characters that is expected to be terminated with a null byte (`'\0'`).
- Example

```
char   s[10];
strcpy(s, "Hello");
```



Initializing C Strings

- Writing:

```
char    yourString[11] = "Do Be Do";
char    myString[] = "Do Be Do";
```

  will initialize both strings with “Do Be Do” with a null byte immediately after “Do Be Do”.

- Writing

```
char    s[] = "abc";
```

  and

```
char    s[] = {'a', 'b', 'c', '\0'};
```

  produce the same string

Pitfall: Using =

- C-strings and C-string variables are different from other data types.
- While you can declare a string by writing

```
char   s[] = "Hello";
```

You cannot write

```
char   s[10];
s = "Hello";
```

Pitfall: Using ==

- C-strings and C-string variables cannot be compared correctly using ==.
- If you write

```
if (s1 == s2)
   printf("The same");
else
   printf("Different");
```

you are comparing their starting addresses.

- Instead, use

```
if (strcmp(s1, s2) == 0)
… …
```

Predefined Functions in `<string.h>`

Function	Description	Caution
`strcpy(s, t)`	Copies t into s	No bounds checking
`strncpy(s, t, n)`	Copies t into s but no more than n characters are copied	Not implemented in older versions of c
`strcat(s, t)`	Concatenates t to the end of s	No bounds checking
`strncat(s, t, n)`	Concatenates t to the end of s but no more than n characters	Not implemented in older versions of c
`strlen(s)`	Returns the length of s (not counting '\0')	
`strcmp(s, t)`	Returns 0 if s == t < 0 if s < t > 0 if s > t	No bounds checking
`strncmp(s, t, n)`	Same as strcmp but compares no more than n characters	Not implemented in older versions of c

`strcpy()`

- `strcpy(s, t)` copies the contents of `t` into `s`.
- This is standard way of assigning a value to a string, i.e., we copy it character by character instead of copying over the address at which it starts.

`strcpy()` – A Example

```
#include    <stdio.h>

int   main(void)
{
      char  s[80];

      strcpy(s, "Let's learn strings");
      printf("%s", s);

      return(0);
}
```

Output

```
Let's learn strings
```

`strncpy()`

- **`strncpy(s, t, n)`** copies the contents of **`t`** into **`s`** but no more than n-1 characters.
- This is standard way of assigning a value to a string, i.e., we copy it character by character instead of copying over the address at which it starts.

`strncpy()` – An Example

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

int   main(void)
{
      char  s[80], t[80];

      strcpy(s, "The quick brown fox jumped "
            "over the lazy dogs");
      strncpy(t, s, 10);
      /*
       * You need this in case s was more
       * than 10 characters
       */
      t[10] = '\0';
```

```
      printf("s = \"%s\"\n", s);
      printf("t = \"%s\"\n", t);

      return(0);
}
```

strcat()

- **strcat(s, t)** concatenates **s** and **t**, saving the new string in **s**.
- Example

```
strcpy(s, "Robert");
strcpy(t, "Michael");
strcat(s, t);
printf("s = \"%s\"\n", s);
```

Output

```
s = "RobertMichael"
```

strncat()

- **strncat(s, t, n)** concatenates **s** and **t**, saving the new string in **s**. At most it will copy **n** characters.
- Example

```
strcpy(s, "Robert");
strcpy(t, "Michael");
strncat(s, t, 5);
printf("s = \"%s\"\n", s);
```

Output

```
s = "RobertMicha"
```

strlen()

- **strlen(s)** returns the number of characters in the string **s**.
- Example

```
strcpy(s, "The quick brown fox");
len = strlen(s);
printf("\"%s\" has %d characters.\n", s, len);
```

- Output

```
"The quick brown fox" has 19 characters.
```

strcmp()

- **strcmp(s, t)** compares **s** and **t** returns an integer:
- If **s** precedes **t** in collating sequence, **strcmp(s, t)** < 0
- If **s** and **t** are the same, **strcmp(s, t)** = 0
- If **s** follows **t**, **strcmp(s, t)** > 0

`strcmp()` – An example

```
#include<stdio.h>

char  r[] = "The quick brown fox",
      s[] = "His quick brown fox",
      t[] = "Your quick brown fox";

int   main(void){
      printf("strcmp(r, s) = %d\n", strcmp(r, s));
      printf("strcmp(r, t) = %d\n", strcmp(r, t));
      printf("strcmp(r, r) = %d\n", strcmp(r, r));

      return(0);
}
```

Output

```
strcmp(r, s) = 1
strcmp(r, t) = -1
strcmp(r, r) = 0
```

`strncmp()`

- **`strncmp(s, t)`** compares up to the first n characters of **`s`** and **`t`** returns an integer:
- If **`s`** precedes **`t`** in collating sequence, **`strncmp(s, t)`** < 0
- If **`s`** and **`t`** are the same, **`strncmp(s, t)`** $= 0$
- If **`s`** follows **`t`**, **`strncmp(s, t)`** > 0

`strncmp()` – An example

```
#include    <stdio.h>

char  r[] = "The quick brown fox",
            s[] = "His quick brown fox",
            t[] = "Your quick brown fox";
int   main(void)  {
  printf("strncmp(r, s, 8) = %d\n",
                  strncmp(r, s, 8));
  printf("strncmp(r, t, 8) = %d\n",
                  strncmp(r, t, 8));
  printf("strncmp(r, r, 8) = %d\n",
                  strncmp(r, r, 8));

  return(0);
}
```

`strncmp()` – An example

Output

```
strcmp(r, s, 8) = 1
strcmp(r, t, 8) = -1
strcmp(r, r, 8) = 0
```

Example: Command-Line Arguments

- Command line parameters are entered when invoking the program using a command-line interface.
- Example:

```
myProg This is a test
```

args.c

```
#include        <stdio.h>

int   main(int argc, char *argv[]) {
   int     i;

   for (i = 0;  i < argc;  i++)
      printf("Argument #%d is %s\n", i, argv[i]);

   return(0);
}
```

Output for **`args.c`**

```
C:\Users\Robert M.
Siegfried\Documents\Visual Studio
2008\Projects\args\Debug>args This is a test
Argument #0 is args
Argument #1 is This
Argument #2 is is
Argument #3 is a
Argument #4 is test

C:\Users\Robert M.
Siegfried\Documents\Visual Studio
2008\Projects\args\Debug>
```

String: Input and Output

- In addition to **`scanf()`** and **`printf()`**, there are other input methods available when working with characters and strings:
  - **`getchar()`**
  - **`gets()`**
  - **`gets_s()`**
  - **`putchar()`**
  - **`puts ()`**

`getchar()`

- **`getchar()`** returns a character from the input stream.
- The progam will for input until the Enter (or Return) key is pressed. It will then return the input from the line character by character.
- Older versions of getchar() define `0` as the End of File marker (**`EOF`**); newer versions use -1 instead; therefore, it is accepted practice to use **`getchar()`** to assign the character to an integer variable.

`getchar()` – An Example

```
#include    <stdio.h>
/* main() - Copy input to output */
int main(void) {
      int c;

      c = getchar();
      while (c != EOF) {
            printf("%c", c);
            c = getchar();
      }
      return(0);
}
```

Output From Our Example

```
This is the start of something big
This is the start of something big
```

`gets ()`

- **`gets()`** can be used to read an entire string up until the next newline character.
- Because **`gets()`** does not include bounds checking, it was deprecated in the 1999 C standard and made obsolete in the 2011 standard.

gets_s()

- **gets_s()** is an improved version of gets that does bounds checking.
- Example

```
int main(void) {
   char s[81];

   gets_s(s, 30);
   printf("\"%s\"\n", s);
   return(0);
}
```

putchar()

- **putchar()** displays the next character that it is given as a parameter.
- Example

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

   while ((c = getchar()) != EOF)
         putchar(c);

   return(0);
}
```

puts()

- **puts()** will print a string passed as a parameter.
- Example

```
int main(void) {
    int   s[41];

    gets_s(s, 40);
    puts(s);

    return(0);
}
```

Functions in <ctype.h>

Function	Description	Example
toupper(c)	Returns the upper case version of the character	c = toupper('a');
tolower(c)	Returns the lower case version of the character	c = tolower('A');
isupper(c)	Returns true if c is an upper case letter	if (isupper(c)) printf("upper case");
islower(c)	Returns true if c is an lower case letter	if (islower(c)) printf("lower case");
isalpha(c)	Returns true if c is a letter	if (isalpha(c)) printf("it's a letter");
isdigit(c)	Returns true if c is a digit (0 through 9)	if (isalpha(c)) printf("it's a number");

Functions in `<ctype.h>` (continued)

Function	Description	Example
`isalnum(c)`	Returns true if c is alphanumeric	`if (isalnum('3')) printf("alphanumeric");`
`isspace(c)`	Returns true if c is a white space character	`while (isspace(c)) c = getchar();`
`ispunct(c)`	Returns true if c is a printable character other than number, letter or white space	`if (ispunct(c)) printf("punctuation");`
`isprint(c)`	Returns true if c is a printable character	
`isgraph(c)`	Returns true if c is a printable character other an white space	
`isctrl(c)`	Returns true if c is a control character	

In C, Characters are Integers

- In many ways, C considers characters to be 8-bit unsigned integers. For this reason, many string functions return an **`int`** value.
- Using **`printf`** to write **`toupper`**(**`'a'`**) will not only write **`'A'`** but the numeric code that represents **`'A'`** depending on the field specifier that you use.

`toupper()` – An Example

```
printf("%d\t %c\n", toupper('a'), toupper('a'));
```

Output

```
65    A
```

String Processing in C

- Despite C's lack of direct support of strings. it can be used easily to handle all kinds of string processing.

mycount.c

```
#include
#define YES 1
#define NO 0
/*
 * main() - Count the lines, words and
 * characters in the input
 */
int main(void) {
      int c, nl, nw, nc, inword;
```

```
      inword = NO; /* We aren't in a word yet */
      nl = nw = nc= 0;
      while((c = getchar()) != EOF) {
            nc++;
            if (c == '\n')
                  nl++;
            if (c == ' ' || c == '\n' || c == '\t')
                  inword = NO; /* Our word ended */
            else if (inword == NO) {
                  /* New word started */
                  inword = YES;
                  nw++;
            }
      }
```

```
        printf("Lines = %d\tword = %d\t"
                    "characters = %d\n",nl, nw, nc);
        return(0);
}
```

CountDigits.c

```
#include    <stdio.h>

/*
 * main() - Count digits, whitespace, and other
 * characters
 */
int main(void) {
        int c, i, nwhite, nother;
        int ndigit[10];
        nwhite = nother = 0;

        for (i = 0; i < 10; i++)
                ndigit[i] = 0;
```

```
        while ((c = getchar()) != EOF)
                /* c - '0' is the value of the digit */
                if ('0' <= c && c <= '9')
                        ++ndigit[c-'0'];
                else if (c == ' ' || c == '\t'
                                        || c == '\n')
                        nwhite++;
                else nother++;

        printf("digits = ");
        for (i = 0; i < 10; i++)
                printf(" %d ", ndigit[i]);

        printf("\nwhite space = %d\t"
                "other = %d\n", nwhite, nother);
        return(0);
}
```

squeeze.c

```
#include <stdio.h>

char line[] =
{"This is the start of a very big deal of a line"};

void squeeze(char s[], char c);

int main(void) {
        printf("My line is:\n\"%s\"\n", line);
        squeeze(line, 'i');
        printf("My line is:\n\"%s\"\n", line);
        return(0);
}
```

```
/*
 * squeeze() - delete all c's from s
 */
void squeeze(char s[], char c) {
      int i, j;
      for (i = j = 0; s[i] != '\0'; i++)
            if (s[i] != c)
                  s[j++] = s[i];
      s[j] = '\0';
}
```

strlen()

```
/*
 * strlen() - Return the length of string s
 */
int strlen(char s[]) {
      int i;

      /* Advance to the null byte at the end */
      for (i = 0; s[i] != '\0'; i++)
            ;

      return(i);
}
```

strcpy()

```
/*
 * strcpy() - Copy t into s one character at a time
 */
void strcpy(char s[], char t[]) {
      int i;

      /* Until we reach the final null byte */
      for (i = 0; t[i] != '\0'; i++)
            /* Copy the current character */
            s[i] = t[i];

      s[i] = '\0';
}
```

strcat()

```
/*
 * strcat() - Concatenate t to s
 */
void strcat(char s[], char t[]) {
      int i, j;

      /* Skip to the end of s */
      for (i = 0; s[i] != '\0'; i++)
             ;

      /* Copy t nto the end of s */
      for (j = 0; t[j] != '\0'; i++, j++)
            s[i] = t[j];
      s[i] = '\0';
 }
```

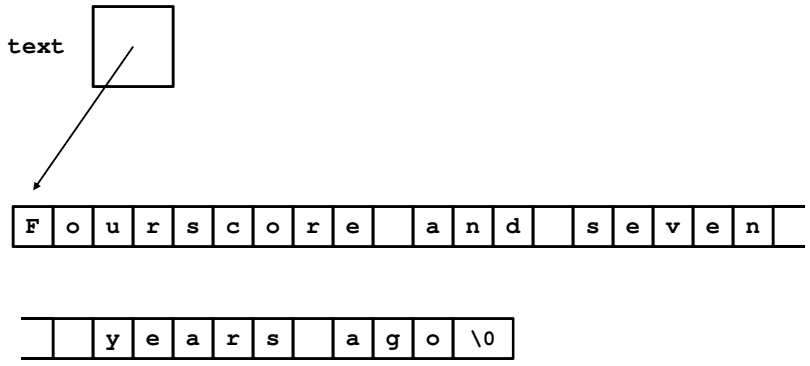
atoi()

```
/*
 * atoi() - The function accepts a character string
 * and translates it into the integer that it
 * represents. It assumes that the first
 * nondigit is the end of the number.
 */
int atoi(char s[]) {
      int i, n = 0;

      for (i = 0; '0' <= s[i] && s[i] <= '9'; i++)
            n = 10*n + s[i] - '0';

      return(n);
}
```

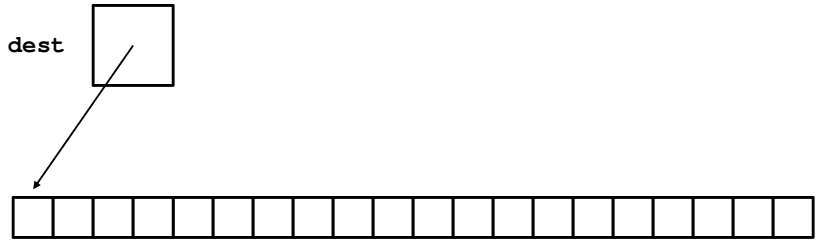
lower()

```
/*
 * lower() - Convert a character to lower case
 */
int lower(int c) {
      if ('A' <= c && c <= 'a')
            return(c + 'a' - 'A');
      else
            return(c);
}
```

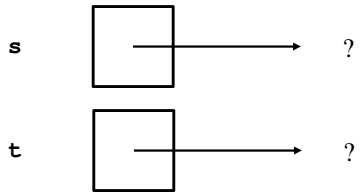
```
char    text[] = "Fourscore and seven years ago";
```



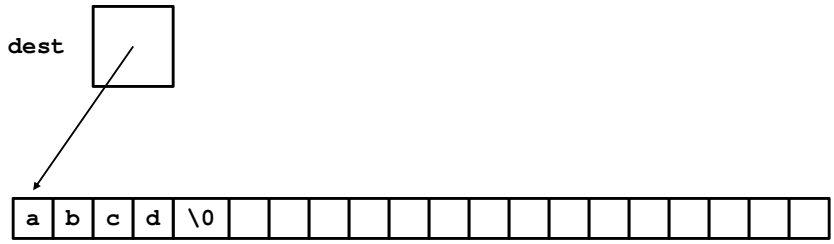
```
char    dest[20];
```



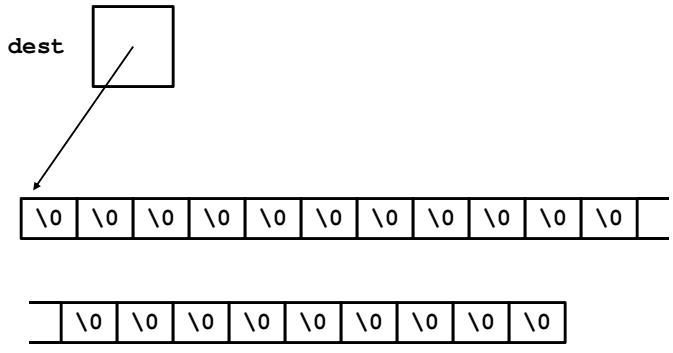

```
char    *s, *t;
```



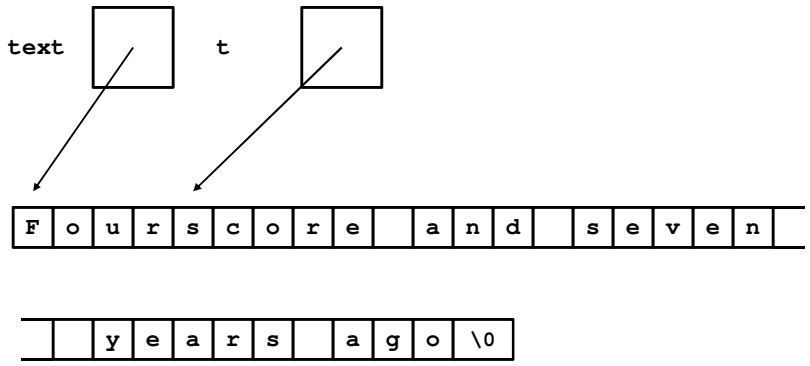
```
strncpy(dest, "abcd", 10);
```



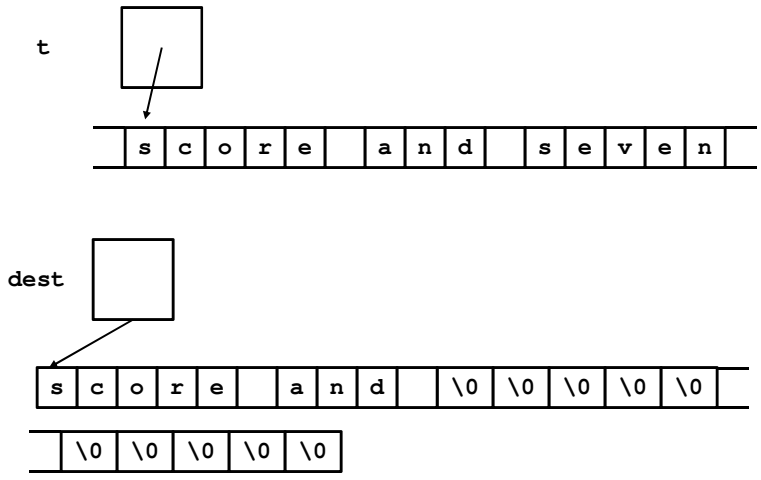

```
memset(dest, '\0', sizeof(dest));
```



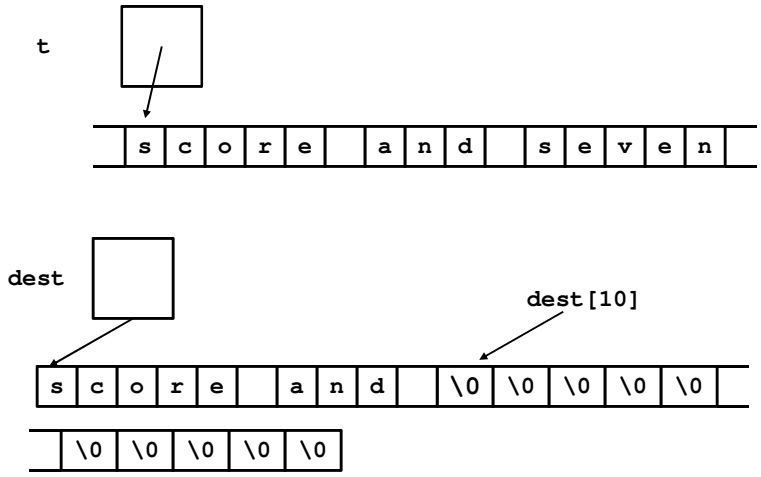
t = strstr(text, "score");



strncpy(dest,t, 10);



dest[10] = '\0';



substring.c

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

char    text[] = "Fourscore and seven years ago";

int     main(void)      {
        char    dest[20];
        char    *s, *t;
        int     i;

        strncpy(dest, "abcd", 10);
        printf("%s\n", dest);
```

```
        memset(dest, '\0', sizeof(dest));
        t = strstr(text, "score");
        strncpy(dest,t, 10);
        dest[10] = '\0';

        for (i = 0; i < 20; i++)
                putchar(dest[i]);
        putchar('\n');
        for (i = 0; i < 20; i++)
                printf("%d  ", (int)dest[i]);
        putchar('\n');

        for (i = 0; i < 20; i++)
                printf("%d  ", (int)t[i]);
        putchar('\n');
```

```
        printf("%s\n", t);
        printf("%s\n", dest);
        return(0);
}
```

The output from **substring.c**

```
abcd
score and
115  99  111  114  101  32  97  110  100 ⌋
32 0  0  0  0  0  0  0  0  0
115  99  111  114  101  32  97  110  100 ⌋
32  115  101  118  101  110  32  121  101 ⌋
97  114
score and seven years ago
score and
```

strstr() Example

```
/* strstr example */
#include <stdio.h>
#include <string.h>

int main () {
      char str[] = "This is a simple string";
      char * pch;
      int i;
```

```
        pch = strstr (str,"simple");
        puts(pch);
        i = pch-str;
        printf("i = %d\n", i);
        strncpy (pch,"sample",6);
        puts (str);
        return 0;
}
```