CSE 142 Programming I

Strings

Chapter 9

Read Sections 9.1, 9.2, and 9.4:

9.1: String Basics

Table 9.1 for summary of common functions

9.2: String Assignment

9.4: String Comparison

Character Data in Programs

•Names, messages, labels, headings, etc.

•All of these are common in computer applications

•All involve characters: usually multiple characters

•So far, our ability to handle these things in C is very limited

Characters and Strings

•Character constants (literals): single quotes

•'a', 'A', '0', '1', '\n', ' ', 'B', 'i', 'l' , '\0' ← the null character

•String constants (literals): double quotes

•"Bill"

•"Mary had a little %c%c%c%c. \n"

•Character variables:

char va = 'l', vb = 'a', vc = 'm', vd = 'b';

printf("Mary had a little %c%c%c%c.\n",va,vb,vc,vd);

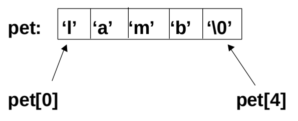
Strings

•Strings: arrays of char

char pet[5] = { 'l', 'a', 'm', 'b', '\0' };

printf("Mary had a little %s . \n", pet);

•More accurate: ***null-terminated*** ***array of char***



•Strings are not quite a full-fledged type in C

•Programmer must take pains to ensure '\0' is present

String Initializers

char pet[5] = { 'l', 'a', 'm', 'b', '\0' } ;

char pet[5] ;
pet[0] = 'l' ; pet[1] = 'a' ; pet[2] = 'm' ;
pet[3] = 'b' ; pet[4] = '\0' ;

char pet[5] = "lamb" ;
char pet[ ] = "lamb" ;

all equivalent

But Not:

char pet[5];
pet = "lamb" ; /* No array assignment in C */

Remember that initializers are not assignment statements!

Things You Can and Can’t Do

- You can’t

  use = to assign one string variable to another (use library functions *strcpy* etc.)
- You can’t

  use == to directly compare strings (use library functions *strcmp* etc.)
- You can’t

  have a string as a function return type
- You can

  directly *scanf* or *printf* strings (use %s)

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Do-It-Yourself String Assignment

```
char str1[10], str2[ ] = “Saturday” ;
int i ;
/* can’t do: str1 = str2 ; */
/* can do: */
i = 0 ;
while (str2[i] != ‘\0’) {
    str1[i] = str2[i] ; i = i + 1;
}
str1[i] = ‘\0’;
```

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String Assignment with *strcpy*

```
/* strcpy is defined in string.h:
   copy source string into dest, stopping with \0 */
void strcpy(char dest[ ], char source[ ])
{
    int i = 0;
    while (source[i] != ‘\0’) {
      dest[i] = source[i] ; i = i + 1;
    }
    dest[i] = ‘\0’ ;
}
```

2/29/00 N-9

String Assignment: Dangers

```
#include <string.h>
...
char medium[ ] = “Four score and seven” ;
char big[1000] ;
char small[5] ;

strcpy(big, medium) ;
strcpy(big, “Bob”) ;
strcpy(small, big) ;
strcpy(small, medium) ;   /* looks like trouble... */
```

2/29/00 N-10

strcpy results

```
medium:  Four score and seven\0
big:     Four score and seven\0?????...
big:     Bob\0 score and seven\0?????...
small:   Bob\0?
small:   Four score and seven\0
```

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String Length: *strlen* (in *string.h*)

```
/*  * return the length of string  s, i.e.,
 *    number of characters before terminating ’\0’,
 *    or equivalently, index of first ’\0’.
*/
int strlen( char s[ ] )
{
    int n = 0;
    while ( s[n]  != ‘\0’)
      n = n + 1 ;
    return (n) ;
}
```

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Length Examples

```
#include <string.h>        /* defn of strlen, strcpy*/
...
char pet[ ] = “lamb”;
int len1, len2, len3, len4, len5;
                                     0 1 2 3 4 5 6
len1 = strlen(pet);                  l a m b \0
len2 = strlen(“wolf”);               w o l f \0
len3 = strlen(“”);                   \0
len4 = strlen(“Help\n”);             H e l p \n \0
strcpy(pet, “cat”);
len5 = strlen(pet);                  c a t \0 \0
```

Example Use of *strlen*

```
#include <string.h>        /* defn of strlen, strcpy*/
char small[5];
...
if ( strlen(medium) <= 4 )
    strcpy(small, medium) ;

else
    printf (“String is too long to copy.\n”) ;
```

String Concatenation

```
#include <string.h>
...
char str1[ ] = “lamb”, str2[ ] = “chop”;
char str3[11];

strcpy(str3, str1);
strcat(str3,str2);

/* strcat(s1, s2) -- make a copy of s2 at the end of s1.  */
```

strcat results

str1	`l a m b \0`
str2	`c h o p \0`
str3	`? ? ? ? ? ? ? ? ? ? ?`
str3	`l a m b \0 ? ? ? ? ? ?`
str3	`l a m b c h o p \0 ? ?`

Comparing Strings

***str_1* is less than *str_2* if j is the first position where they differ and str_1[j] < str_2[j].**

“lamb” is less than “wolf”   j = 0, ‘l’ < ‘w’

“lamb” is less than “lamp”   j = 3, ‘b’ < ‘p’

“lamb” is less than “lambchop” j = 4, ‘\0’ < ‘c’

String Comparison Errors

***str1 = str2;* Syntax “error”**

***if (str1 == str2)…* No syntax error (but almost surely a logic error)**

***if (str1 < str2)…*   Likewise**

Correct String Comparison

```
/* function strcmp in <string.h> */
int strcmp(char str_1[ ], char str_2[ ]);
```

The integer returned is:

negative	if *str_1* less than *str_2*
zero	if *str_1* equals *str_2*
positive	if *str_2* less than *str_1*

Common errors: if (!strcmp(str1, str2))… means "if they ARE equal"

2/29/00 N-19

String Input and Output

- *scanf* with "%s"
  - Skips initial whitespace
  - Inserts '\0' at next whitespace
  - Danger: no length check
    - a malicious user could cause harm

```
char in_string[10];
scanStatus = scanf ("%s", in_string);
```

no &

- *printf* with "%s"

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Do-It-Yourself Whole Line Input

```
char line [LENGTH + 1] ;
int i , scanStatus;

/* read input characters into line until end of input line
   reached or all available space in line used */
i = 0;
scanStatus = scanf ("%c", &line[i]) ;
while (1 ==scanStatus &&  i < LENGTH  &&  line[I-1] != '\n') {
     i++;
     scanStatus = scanf ("%c", &line[i]) ;
     }
}
line [i] = '\0' ; /* is this a bug? */
```

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Arrays of Strings

```
char month[12][10] = {
    "January",
    "February",
    ...
    "September",/* longest month: 9 letters */
    ...
    "December" } ;
...
printf ("%s is hot \n", month[7] );      /* August */
```

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Reading and Printing Strings

```
char name [NUM_NAMES] [MAX_NAME + 1] ;
int age [NUM_NAMES], i ;
for ( i = 0 ;  i < NUM_NAMES ;  i = i + 1 )
{
    scanf ("%s %d", name[i], &age[i]) ;
    printf ("%s %d \n", name[i], age[i]) ;
}
```

no &

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Many Functions in <string.h>

strcat, strncat	concatenation
strcmp, strncmp	comparison
strtod, strtol, strtoul	conversion

Lots of others: see Appendix B.

Related useful functions in <ctype.h>
operations on a single char:
convert case, check category, etc.
See textbook Table 9.3 and Appendix B

2/29/00 N-24

Using Libraries of Functions

- To use strings effectively in C, use functions from *string.h*
- Using libraries is very typical of C programming
  - –ANSI C standard libraries such as *stdio.h, string.h, ctype.h*
  - –Application-specific libraries: *cpanel.h, GP142.h*, etc. (thousands of them exist)
- *You can't be an effective programmer without being able to quickly master new libraries of functions*

Strings Summary

- Definition: Null-terminated array of char
- A convention, not a first-class citizen
  - E.g., no string assignment or compare in the C language itself
- *scanf/printf*: %s
- <string.h> library functions
  - Assignment: *strcpy, strncpy*
  - Length: *strlen*
    - reminder: length of contents, not container
  - *strcat* and many others
- Major Pitfall: overrunning available space