(9-2) Strings I
H&K Chapter 8

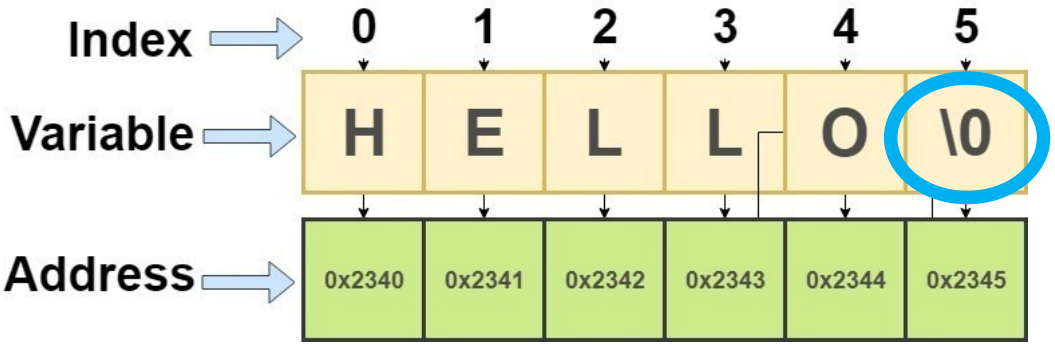
Instructor – Beiyu Lin

CptS 121 (May 29th, 2019)

Washington State University

String Fundamentals

- A string is a sequence of characters terminated by the null character ('\0')
  - "This is a string" is considered a string literal
  - A string may include letters, digits, and special characters
- A string may always be represented by a character array, but a character array is not always a string
- A string is accessed via a **pointer** to the first character in it



Graph is from: https://simplesnippets.tech/cpp-strings-with-explanation-example/

String Basics (1)

- Whether you realize it or not, you've been working with C strings all semester:

- It's just that we haven't ever declared a string variable. In C, a string is represented as an array of characters:

```
char name [20]; /* declares a variable name that can hold a
                   string of length 20 */
```

- Be sure to always account for the '**\0**' in your **array** declarations
  - name[ ] may have up to 19 characters + 1 for the null character

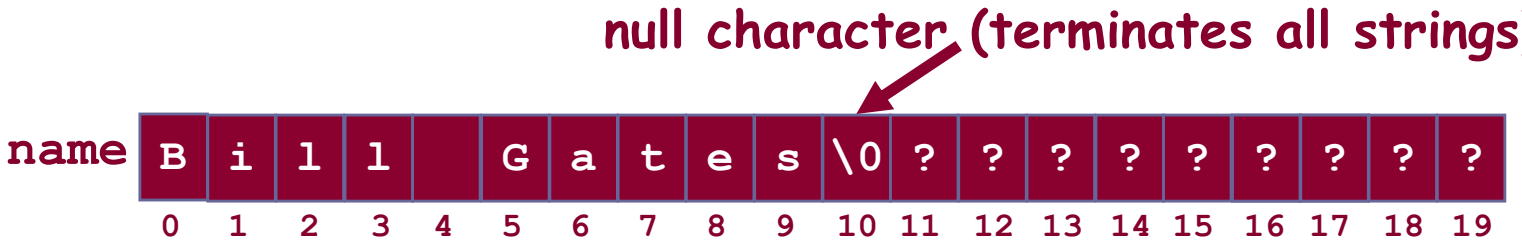
String Basics (2)

- As with other data types, we can even initialize a string when we declare it:

```
char name[20] = "Bill Gates";
char *name = "Bill Gates";
char name[] = {'B', 'i', 'l', 'l', ' ', 'G', 'a', 't', 'e',
               's', '\0';}
// These are equivalent string declarations!
```

More examples were included in class both on the whiteboard and during live coding.

- Here's what the memory allocated to `name` looks like after either of the above is executed:



String Basics (3)

- Notes on the null character
  - When a string is initialized on the line it is declared, the compiler **automatically** "null terminates" the string
  - All of C's string handling functions work only with null-terminated strings;
  - any characters to the right of the null character are ignored;

Think about "***return***" in a function.

  - The ASCII value of the null character is 0

String Basics (4)

- When a variable of type `char*` is initialized with a string literal, it may be placed in memory where the string can't be modified
- If you want to ensure modifiability of a string store it into a character array when initializing it

String Basics (5)

- Populating a string using scanf ( )

```
char my_string [50];
// The address of operator (&) is not required because the name of the
// array is an address
scanf ("%s", my_string);
```

```
int num;
scanf("%d\n", &num);
```

  - Notes on scanf ( ):
    - Using %s will automatically append a null character to the end of the string
    - Reads character-by-character until whitespace is encountered, i.e. if the user enters: Bill Gates, only "Bill" is read; however, "Gates" is still in the input stream
- Displaying a string using printf ( )

```
printf ("%s\n", my_string);
```

  - Notes on printf ( ):
    - Using %s will display character-by-character until a null character is encountered; white space and printable special characters will be displayed
    - If a null character is missing from the end of the string, all contiguous memory will be printed until a null character happens to be found in memory

String Basics (6)

- Arrays of Strings
  - Suppose we want to store a list of students in a class
  - We can do this by declaring an array of strings, one row for each student name:

```
#define NUM_STUDENTS 5
#define MAX_NAME_LENGTH 31
char student_names[NUM_STUDENTS][MAX_NAME_LENGTH];
```

# of strings

Max length of each string

  - We can initialize an array of strings "in line":

```
char student_names[NUM_STUDENTS][MAX_NAME_LENGTH] =
{"John Doe", "Jane Smith", "Sandra Connor", "Damien White",
 "Metilda Cougar"};
```

More details and examples were written on the white board during the class.

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String Basics (7)

Integer

```
/* 2D array */
int num_arr[2][3];

/*Counter variables */
int i, j;

for(i=0; i<2; i++)
{
  for(j=0;j<3;j++)
  {
     printf(”enter a number\n”);
     scanf("%d", &num_arr[i][j]);
     printf(“%d”, num_arr[i][j]);
  }
}
```

Strings

```
char str_arr[2][3];
int i;
for (i = 0; i < 2; i++)
{
   printf(”enter a string \n");
   scanf("%s",student_names[i]);
   printf(”%s \n", str_arr[i]);
}
```

Quick Review:

char temp_char;

scanf(“ %c”, &temp_char);

More details and examples were written on the white board during the class and during the class live coding.

String Basics (8)

- Just as is the case for `doubles` and `ints`, we can specify a field width in a `printf` statement involving a string (`%s`). By default, the string is right justified within that field, e.g.,

```
printf("string value: %5s\n",my_string);
/* string is right justified within field of 5 */
```

- If we want to left-justify the string, we specify a *negative* field width, e.g.,

```
printf("string value: %-5s\n",my_string);
/* string is left justified within field of 5 */
```

Examples were written on the white board in the class.

String Basics (9)

- Reading in multiple data types alongside the string data type:

```
1.  #include <stdio.h>
2.
3.  #define STRING_LEN  10
4.
5.  int
6.  main(void)
7.  {
8.        char dept[STRING_LEN];
9.        int  course_num;
10.       char days[STRING_LEN];
11.       int  time;
12.
13.       printf("Enter department code, course number, days and ");
14.       printf("time like this:\n> COSC 2060 MWF 1410\n> ");
15.       scanf("%s%d%s%d", dept, &course_num, days, &time);
16.       printf("%s %d meets %s at %d\n", dept, course_num, days, time);
17.
18.       return (0);
19. }

Enter department code, course number, days and time like this:
> COSC 2060 MWF 1410
> MATH 1270 TR 800
MATH 1270 meets TR at 800
```

Other examples were included during the live coding in class.

String Basics (10)

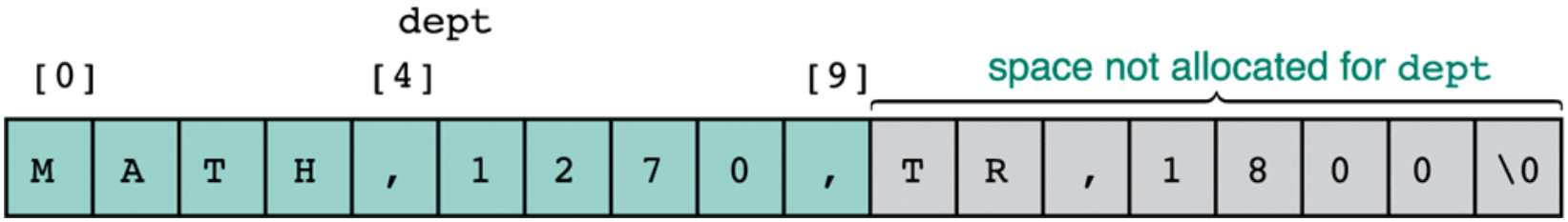
- When the previous program is run and the user enters the following (which is not in the correct format):

  `MATH,1270,TR,1800`

  The `scanf` call

  ```
  scanf("%s%d%s%d",dept,&course_num,days,&time);
  ```

  interprets this all as one string, storing it to `dept` (bad news!):



Moral: We need a more robust way to read in multiple data types (Stay tuned!)

Example were written on the white board.

String Basics (11)

- Example problem:
  - Write a segment of code that prompts the user for a word of length 24 characters or less, and prints a statement like this:

```
fractal starts with the letter f
```

Have the program process words until it encounters a "word" beginning with the character `'9'`.

String Basics (12)

- Solution:

```
#include <stdio.h>
#define STRING_LENGTH 25

int main()
{
  char name[STRING_LENGTH];
  int done;
  do
  {
     done = 0;
     printf("Enter a name ('9') to quit: ");
     scanf("%s",name);
     if (name[0] == '9')
       done = 1;
     else
       printf("%s starts with the letter %c.\n",
              name,name[0]);
   } while (!done);
   return (0);
}
```

Similar example was illustrated in class.

What To Look Forward To…

- More on Strings:
  - String handling library functions
  - Arrays of Pointers
  - Character input/output and robust string input
  - Character conversion
  - String processing example

References

- J.R. Hanly & E.B. Koffman, *Problem Solving and Program Design in C (8th Ed.)*, Addison-Wesley, 2016.
- P.J. Deitel & H.M. Deitel, *C How to Program (7th Ed.)*, Pearson Education , Inc., 2013.

Collaborators

- Chris Hundhausen
- Andrew O'Fallon