Programming and Algorithms

COMP1038.PGA

Week 6 – Lecture 1 & 2: Characters and Strings

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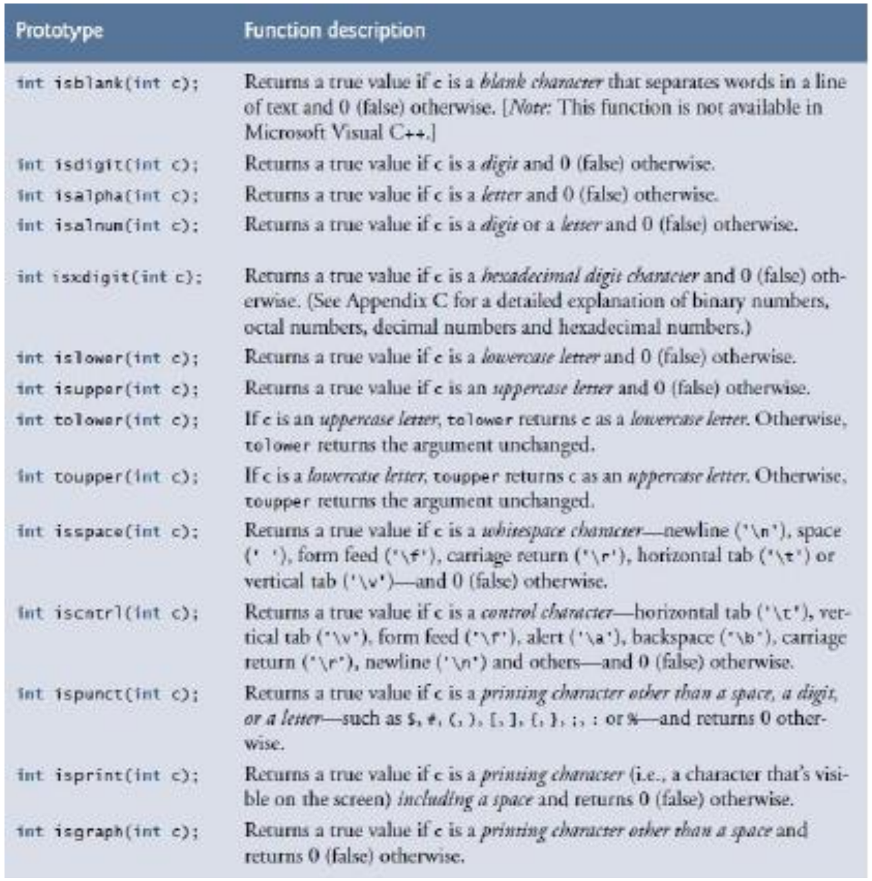
Outline

- Character handling
- Introduction to strings
- Declaration of strings
- Initializing of strings
- Reading strings
- Writing strings
- String handling functions
- Array of strings
- Conclusion

Characters handling

- Character handling functions are inside *ctype.h* header file. So you need to include this header file in your program to use these functions.



Prototype	Function description
`int isblank(int c);`	Returns a true value if `c` is a *blank character* that separates words in a line of text and 0 (false) otherwise. [*Note:* This function is not available in Microsoft Visual C++.]
`int isdigit(int c);`	Returns a true value if `c` is a *digit* and 0 (false) otherwise.
`int isalpha(int c);`	Returns a true value if `c` is a *letter* and 0 (false) otherwise.
`int isalnum(int c);`	Returns a true value if `c` is a *digit* or a *letter* and 0 (false) otherwise.
`int isxdigit(int c);`	Returns a true value if `c` is a *hexadecimal digit character* and 0 (false) otherwise. (See Appendix C for a detailed explanation of binary numbers, octal numbers, decimal numbers and hexadecimal numbers.)
`int islower(int c);`	Returns a true value if `c` is a *lowercase letter* and 0 (false) otherwise.
`int isupper(int c);`	Returns a true value if `c` is an *uppercase letter* and 0 (false) otherwise.
`int tolower(int c);`	If `c` is an *uppercase letter*, `tolower` returns `c` as a *lowercase letter*. Otherwise, `tolower` returns the argument unchanged.
`int toupper(int c);`	If `c` is a *lowercase letter*, `toupper` returns `c` as an *uppercase letter*. Otherwise, `toupper` returns the argument unchanged.
`int isspace(int c);`	Returns a true value if `c` is a *whitespace character*—newline (`'\n'`), space (`' '`), form feed (`'\f'`), carriage return (`'\r'`), horizontal tab (`'\t'`) or vertical tab (`'\v'`)—and 0 (false) otherwise.
`int iscntrl(int c);`	Returns a true value if `c` is a *control character*—horizontal tab (`'\t'`), vertical tab (`'\v'`), form feed (`'\f'`), alert (`'\a'`), backspace (`'\b'`), carriage return (`'\r'`), newline (`'\n'`) and others—and 0 (false) otherwise.
`int ispunct(int c);`	Returns a true value if `c` is a *printing character other than a space, a digit, or a letter*—such as `$`, `#`, `(`, `)`, `[`, `]`, `{`, `}`, `;`, `:` or `%`—and returns 0 otherwise.
`int isprint(int c);`	Returns a true value if `c` is a *printing character* (i.e., a character that's visible on the screen) *including a space* and returns 0 (false) otherwise.
`int isgraph(int c);`	Returns a true value if `c` is a *printing character other than a space* and returns 0 (false) otherwise.

Source: Deitel and Deiltel(2016). C How to Program with an Introduction to C++ (8th Ed.). Pearson.

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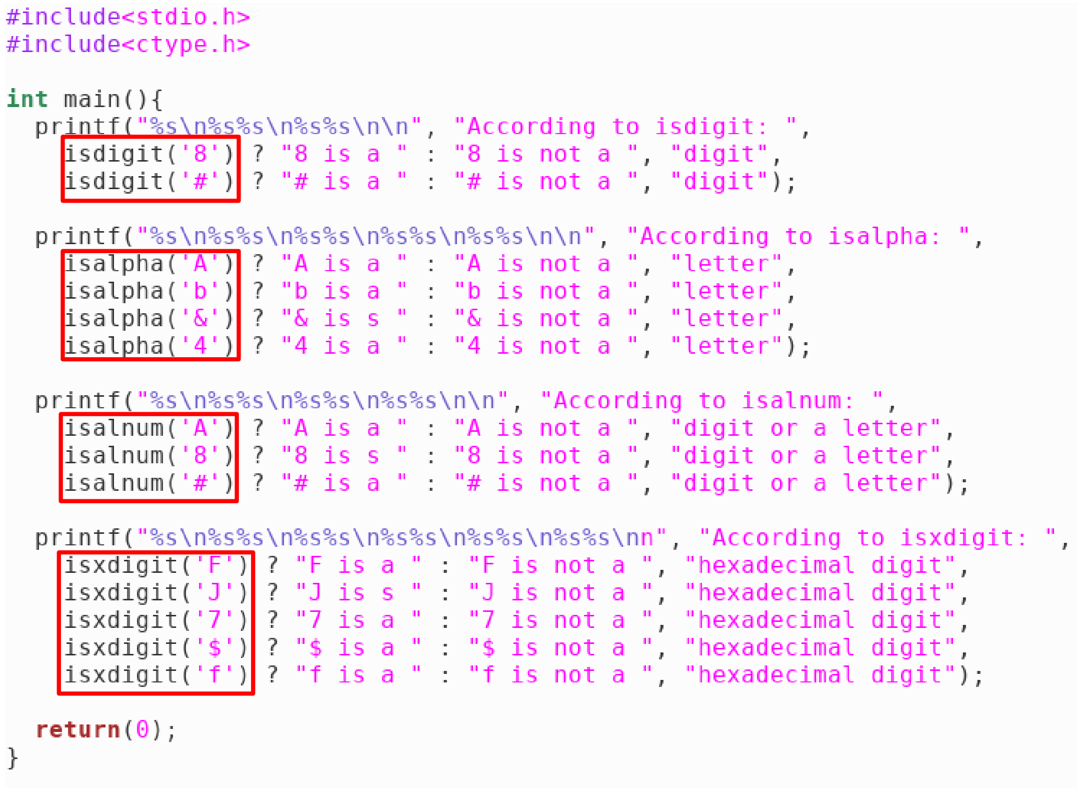
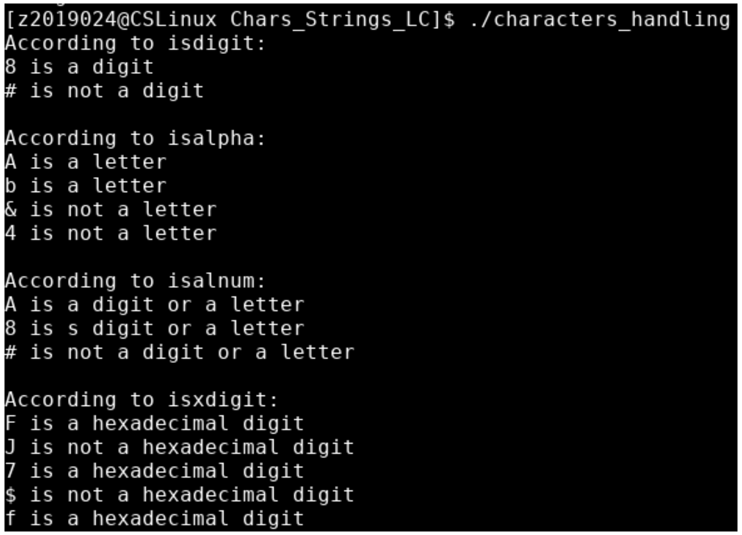
Characters handling cont…



```c
#include<stdio.h>
#include<ctype.h>

int main(){
  printf("%s\n%s%s\n%s%s\n\n", "According to isdigit: ",
    isdigit('8') ? "8 is a " : "8 is not a ", "digit",
    isdigit('#') ? "# is a " : "# is not a ", "digit");

  printf("%s\n%s%s\n%s%s\n%s%s\n%s%s\n\n", "According to isalpha: ",
    isalpha('A') ? "A is a " : "A is not a ", "letter",
    isalpha('b') ? "b is a " : "b is not a ", "letter",
    isalpha('&') ? "& is s " : "& is not a ", "letter",
    isalpha('4') ? "4 is a " : "4 is not a ", "letter");

  printf("%s\n%s%s\n%s%s\n%s%s\n\n", "According to isalnum: ",
    isalnum('A') ? "A is a " : "A is not a ", "digit or a letter",
    isalnum('8') ? "8 is s " : "8 is not a ", "digit or a letter",
    isalnum('#') ? "# is a " : "# is not a ", "digit or a letter");

  printf("%s\n%s%s\n%s%s\n%s%s\n%s%s\n%s%s\nn", "According to isxdigit: ",
    isxdigit('F') ? "F is a " : "F is not a ", "hexadecimal digit",
    isxdigit('J') ? "J is s " : "J is not a ", "hexadecimal digit",
    isxdigit('7') ? "7 is a " : "7 is not a ", "hexadecimal digit",
    isxdigit('$') ? "$ is a " : "$ is not a ", "hexadecimal digit",
    isxdigit('f') ? "f is a " : "f is not a ", "hexadecimal digit");

  return(0);
}
```



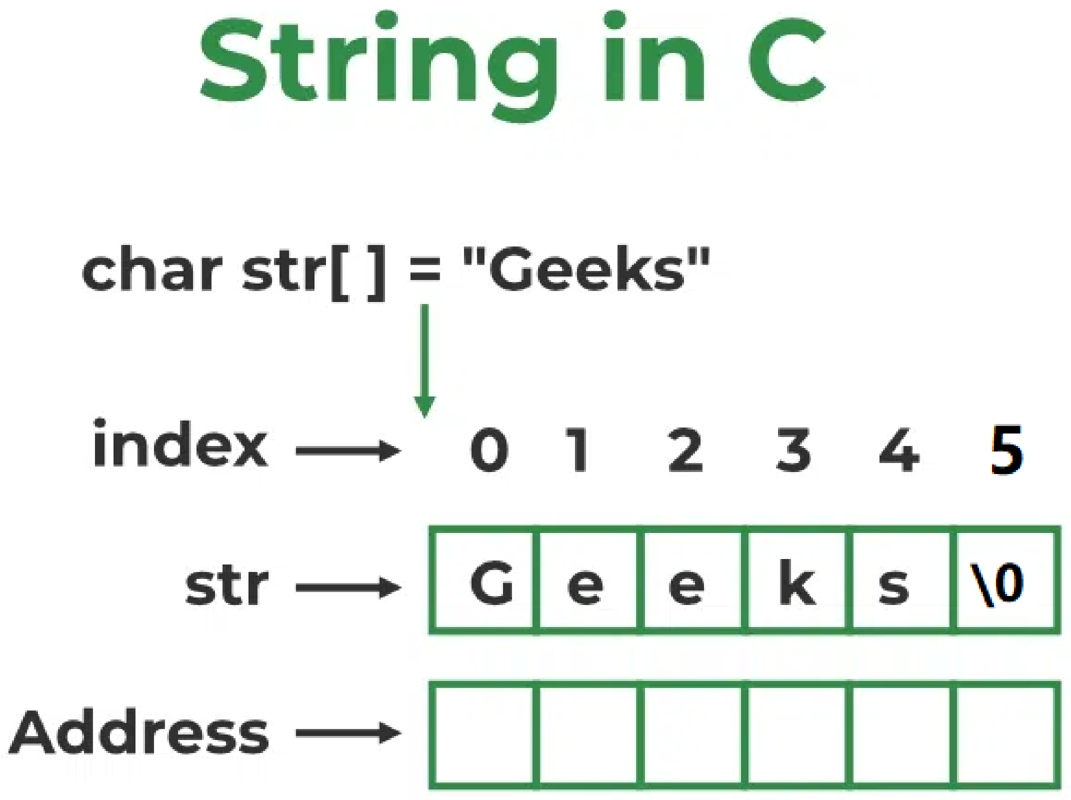
```
[z2019024@CSLinux Chars_Strings_LC]$ ./characters_handling
According to isdigit:
8 is a digit
# is not a digit

According to isalpha:
A is a letter
b is a letter
& is not a letter
4 is not a letter

According to isalnum:
A is a digit or a letter
8 is s digit or a letter
# is not a digit or a letter

According to isxdigit:
F is a hexadecimal digit
J is not a hexadecimal digit
7 is a hexadecimal digit
$ is not a hexadecimal digit
f is a hexadecimal digit
```

Source: Dola saha, C programming for engineer, 2017.

Introduction to strings

- The C language does not have a specific "String" data type, the way some other languages such as C++ and Java do.
- In C language, String is a 1-d array of type char.
- By convention, a string in C is terminated by the end-of-string sentinel '\0' (null character)
- The difference between a character array and a C string is the string is terminated with a unique character '\0'.

Introduction cont…



Source: https://www.geeksforgeeks.org/

```
char string_name[size];
  char string_name[size];
```

String Declaration

- Declaring a string in C is as simple as declaring a one-dimensional array.

  char string_name[size];
- In the above syntax *str_name* is any name given to the string variable and *size* is used to define the length of the string, i.e the number of characters the string will store.
- There is an extra terminating character which is the **Null character ('\o') used to indicate the termination of a string that differs strings from normal character arrays.**

String Literals

- String literal values are represented by sequences of characters between double quotes (“)
- Examples
  - “” - empty string
  - “hello” - a string literal
- “a” versus ‘a’
  - ‘a’ is a single character value (stored in 1 byte) as the ASCII value for a
  - “a” is an array with two characters, the first is a, the second is the character value \o
- 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 (# of characters in the literal + 1)
  - referring to the literal refers to that space (as if it is an array)

String Initialization

A string in C can be initialized in different ways. Below are the examples to declare a string with the name *str* and initialize it with “Nottingham”.

1. **Assigning a string literal without size**
   - String literals can be assigned without size. Here, the name of the string *str* acts as a pointer because it is an array.

     char str[ ] = “Nottingham”;
2. **Assigning a string literal with a predefined size**
   - String literals can be assigned with a predefined size. But we should always account for one extra space which will be assigned to the null character. If we want to store a string of size *n* then we should always declare a string with a size equal to or greater than n+1.

     char str[50] = “Nottingham”;
3. **Assigning character by character with size**
   - We can also assign a string character by character. But we should remember to set the end character as ‘\0’ which is a null character.

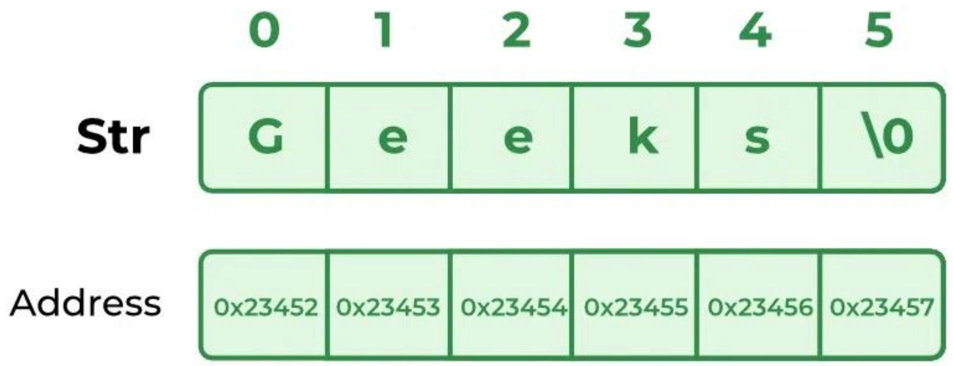
     char str[11] = { 'N','o','t','t','i','n','g','h','a','m','\0'};
4. **Assigning character by character without size**
   - We can assign character by character without size with the NULL character at the end. The size of the string is determined by the compiler automatically.

     char str[ ] = { 'N','o','t','t','i','n','g','h','a','m','\0'};

Note: When a Sequence of characters enclosed in the double quotation marks is encountered by the compiler, a null character ‘\0’ is appended at the end of the string by default.

String Initialization cont…

- Memory presentation



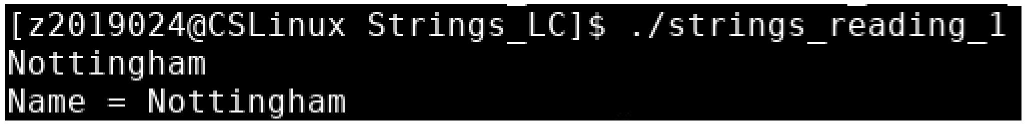
Note: After declaration, if we want to assign some other text to the string, we have to assign it one by one or use built-in strcpy() function because the direct assignment of string literal to character array is only possible in declaration.

Source: https://www.geeksforgeeks.org/

Reading a string

- The C language does not provide an inbuilt data type for strings but it has an access specifier “%s” which can be used to print and read strings directly.

```c
#include<stdio.h>

int main(){
  char name[25];
  scanf("%s", name);
  printf("Name = %s\n", name);
  return(0);
}
```



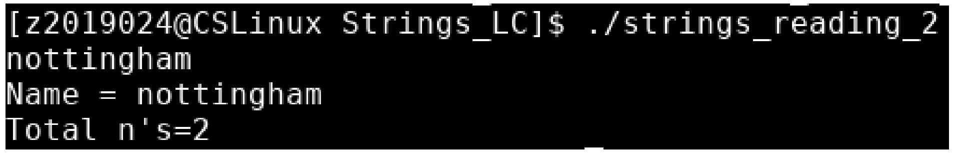
```
[z2019024@CSLinux Strings_LC]$ ./strings_reading_1
Nottingham
Name = Nottingham
```

%s reads a string into a character array given the array name or start address. It ends the string with ‘\o’

Reading a string cont…

- **Reading a string character-by-character**

```c
#include<stdio.h>

int main(){
  int i, count=0;
  char name[25];
  scanf("%s", name);
  printf("Name = %s\n", name);
  for(i=0;name[i]!='\0';i++)
    if(name[i]=='n')count++;
  printf("Total n's=%d\n", count);
  return(0);
}
```



```
[z2019024@CSLinux Strings_LC]$ ./strings_reading_2
nottingham
Name = nottingham
Total n's=2
```

Note that character strings read in %s format end with '\o'

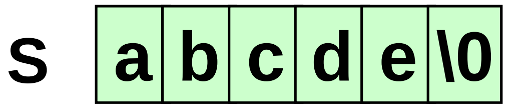
Read the string character-by-character

String array vs string pointer

- **String array**

char s[ ] = “abcde”;
≡ char s[ ] = **{‘a’,’b’,’c’,’d’,’e’,’\o’};**

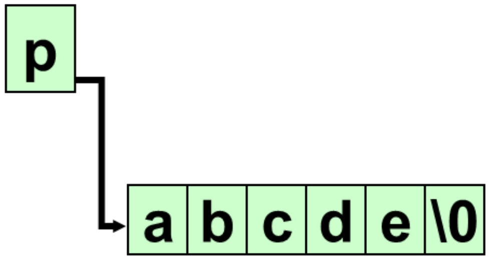
Note: The compiler allocates 6 bytes of memory for the array s which are initialized with the 6 characters



- **String pointer**

char *p = “abcde”;

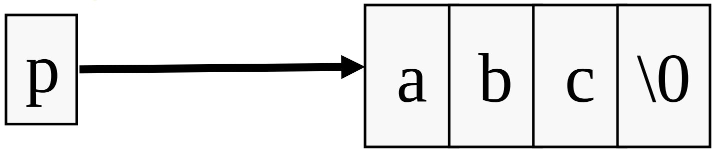
Note: The compiler allocates space for p, puts the string constant “abcde” in memory somewhere else, initializes p with the base address of the string constant



String constant

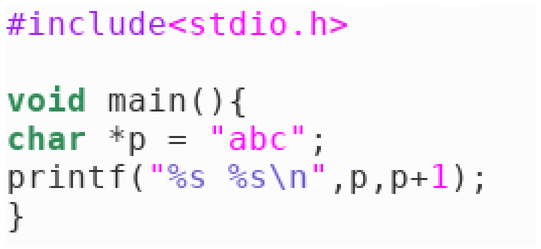
- A string constant is treated as a pointer to the string.
- Its value is the base address of the string

char *p = “abc”;

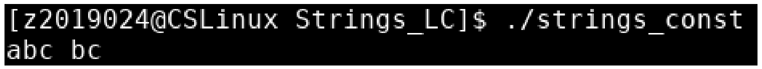


printf (“%s %s\n”,p,p+1);

Output: abc bc



```
#include<stdio.h>

void main(){
char *p = "abc";
printf("%s %s\n",p,p+1);
}
```



```
[z2019024@CSLinux Strings_LC]$ ./strings_const
abc bc
```

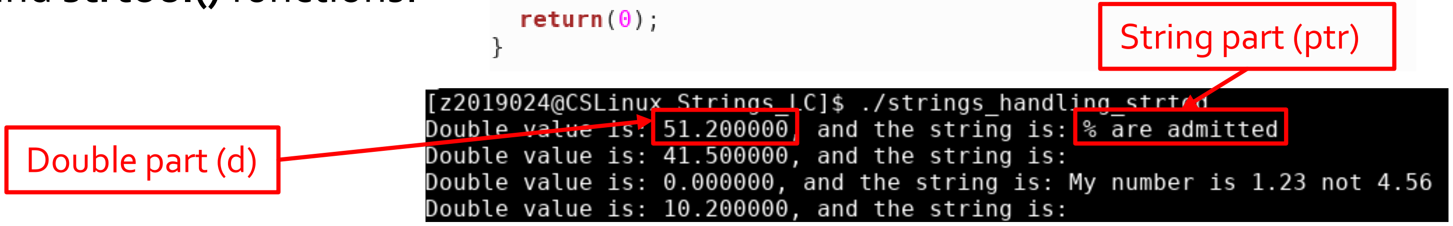
String handling functions

- String-Conversion Functions
  - String conversation functions are inside the *stdlib.h* header file. So you need to include this header file in your program to use these functions.
  - **strtod():** converts a string to double
  - **strtol():** converts a string to long
  - **strtoul():** converts a string to unsigned long
  - **atof():** Converts a string to float
  - **atol():** Converts a string to long integer

String handling functions cont…

- **strtod()**
  - This function separates double value from a string.
  - The string must begins with a valid floating point number.
  - The pointer receives the memory address of the character after floating point value.
  - On error, point to the beginning of the string.
  - Follow the same rules for the **strtol()** and **strtoul()** functions.

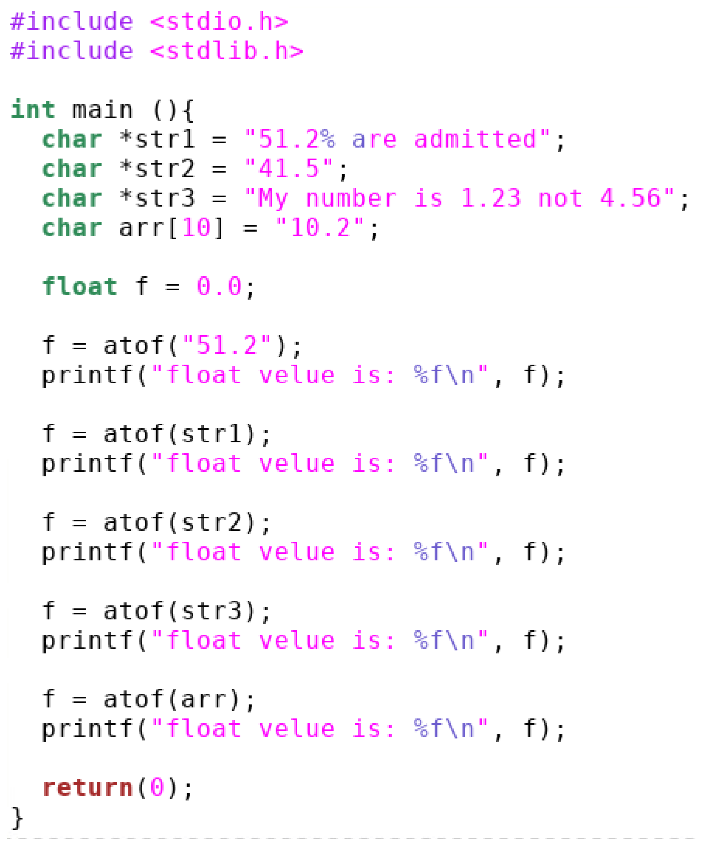
```c
#include <stdio.h>
#include <stdlib.h>

int main (){
  char *str1 = "51.2% are admitted";
  char *str2 = "41.5";
  char *str3 = "My number is 1.23 not 4.56";
  char arr[10] = "10.2";

  char *ptr;
  double d;

  d = strtod(str1, &ptr);
  printf("Double value is: %f, and the string is: %s\n", d, ptr);

  d = strtod(str2, &ptr);
  printf("Double value is: %f, and the string is: %s\n", d, ptr);

  d = strtod(str3, &ptr);
  printf("Double value is: %f, and the string is: %s\n", d, ptr);

  d = strtod(arr, &ptr);
  printf("Double value is: %f, and the string is: %s\n", d, ptr);

  return(0);
}
```



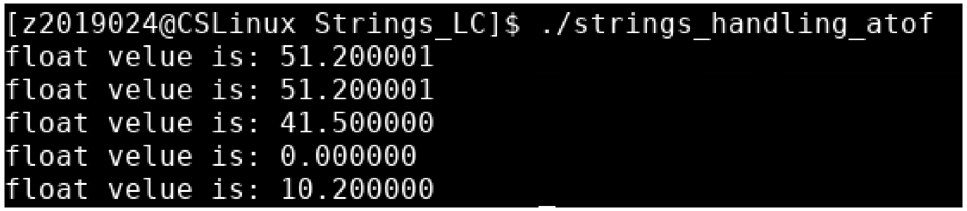
```
[z2019024@CSLinux Strings_C]$ ./strings_handling_strtod
Double value is: 51.200000, and the string is: % are admitted
Double value is: 41.500000, and the string is:
Double value is: 0.000000, and the string is: My number is 1.23 not 4.56
Double value is: 10.200000, and the string is:
```

String handling functions cont…

- **atof()**
  - Converts string to float.
  - The string must begins with or will entirely be a valid floating point number.
  - On error, returns zero value.
  - Follow the same rules for the **atol()** function.



```c
#include <stdio.h>
#include <stdlib.h>

int main (){
   char *str1 = "51.2% are admitted";
   char *str2 = "41.5";
   char *str3 = "My number is 1.23 not 4.56";
   char arr[10] = "10.2";

   float f = 0.0;

   f = atof("51.2");
   printf("float velue is: %f\n", f);

   f = atof(str1);
   printf("float velue is: %f\n", f);

   f = atof(str2);
   printf("float velue is: %f\n", f);

   f = atof(str3);
   printf("float velue is: %f\n", f);

   f = atof(arr);
   printf("float velue is: %f\n", f);

   return(0);
}
```



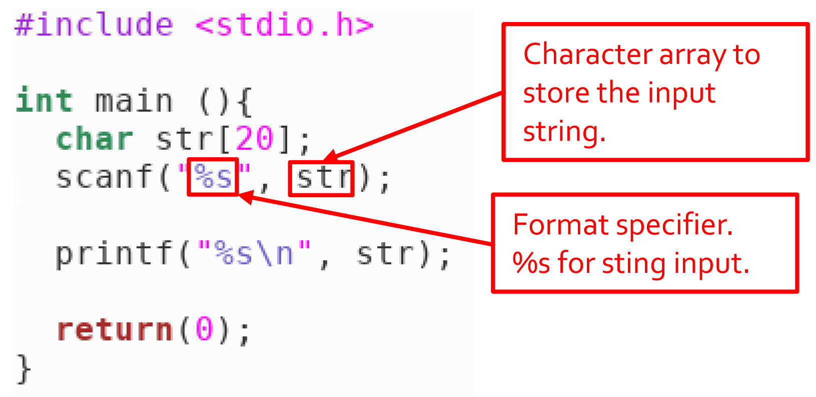
```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_atof
float velue is: 51.200001
float velue is: 51.200001
float velue is: 41.500000
float velue is: 0.000000
float velue is: 10.200000
```

String handling functions cont…

- Standard string input and output functions
  - String input and output functions belong to *stdio.h* header file. So when will use these functions in your program you need to include this header file.
  - String input functions
    - **scanf():** Input a string from a standard keyboard
    - **sscanf():** Input a string from another string
    - **gets():** Input a string from standard keyboard with blank spaces
    - **fgets():** Input a string from standard keyboard/file line-by-line
  - String output functions
    - **printf():** Print a string to a standard display
    - **fprintf():** Print a string to a standard display/file
    - **sprintf():** Write a string to another string
    - **puts():** Print a string to a standard display and add \n at the end of the string

String handling functions cont…

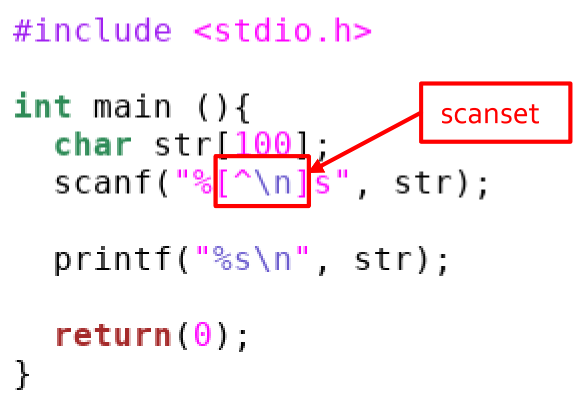
- **scanf()**
  - Input a string from a standard keyboard.
  - Input a string until blank space or newline encounters.
  - This function can input a string with blank space using scanset.



```
#include <stdio.h>

int main (){
   char str[20];
   scanf("%s", str);

   printf("%s\n", str);

   return(0);
}
```

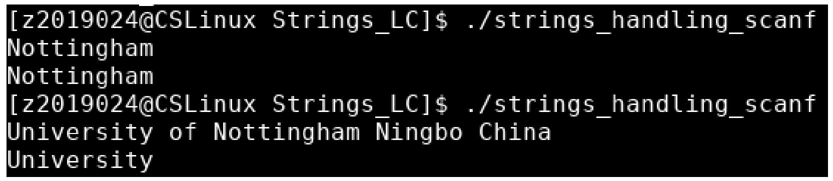
Character array to store the input string.

Format specifier. %s for sting input.

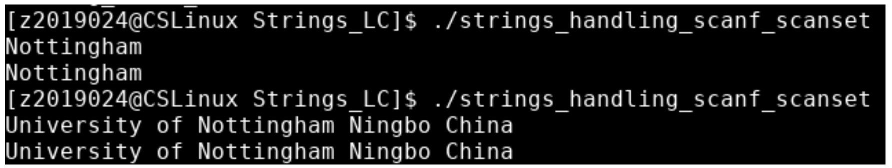


```
#include <stdio.h>

int main (){
   char str[100];
   scanf("%[^\n]s", str);

   printf("%s\n", str);

   return(0);
}
```

scanset



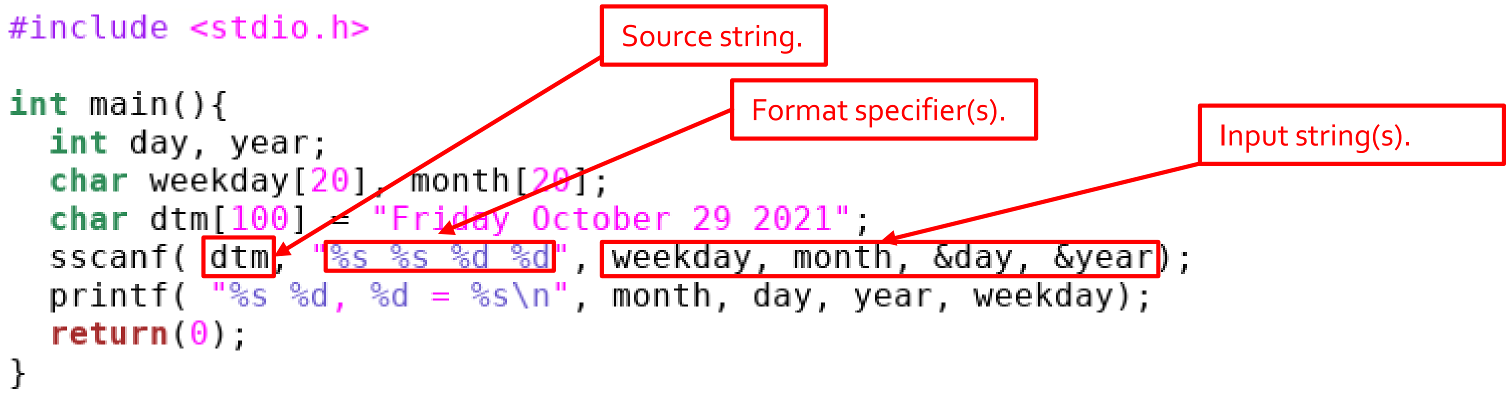
```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_scanf
Nottingham
Nottingham
[z2019024@CSLinux Strings_LC]$ ./strings_handling_scanf
University of Nottingham Ningbo China
University
```



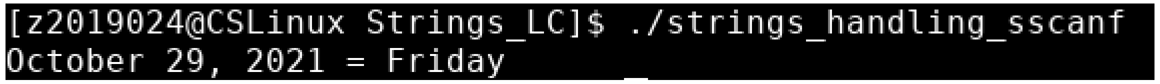
```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_scanf_scanset
Nottingham
Nottingham
[z2019024@CSLinux Strings_LC]$ ./strings_handling_scanf_scanset
University of Nottingham Ningbo China
University of Nottingham Ningbo China
```

String handling functions cont…

- **sscanf()**
  - Input a string from another string e.g. array, instead of keyboard input.



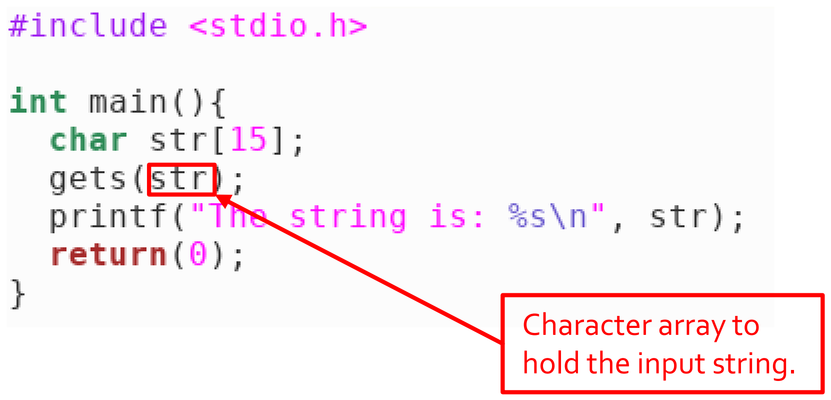
```c
#include <stdio.h>

int main(){
   int day, year;
   char weekday[20], month[20];
   char dtm[100] = "Friday October 29 2021";
   sscanf( dtm, "%s %s %d %d", weekday, month, &day, &year);
   printf( "%s %d, %d = %s\n", month, day, year, weekday);
   return(0);
}
```



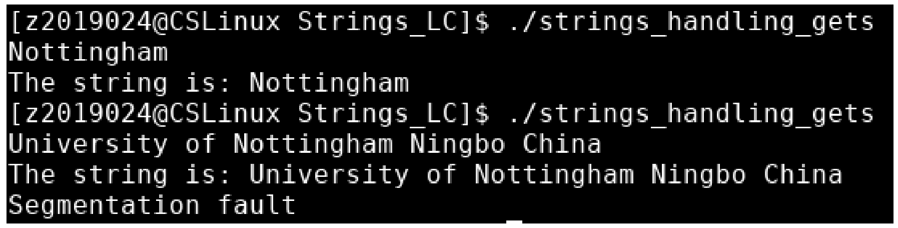
```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_sscanf
October 29, 2021 = Friday
```

String handling functions cont…

- **gets()**
  - Input a string from standard keyboard with blank spaces.
  - It is not safe to use because it does not check the array bound.
  - It is used to read strings from the user until a newline character is not encountered.



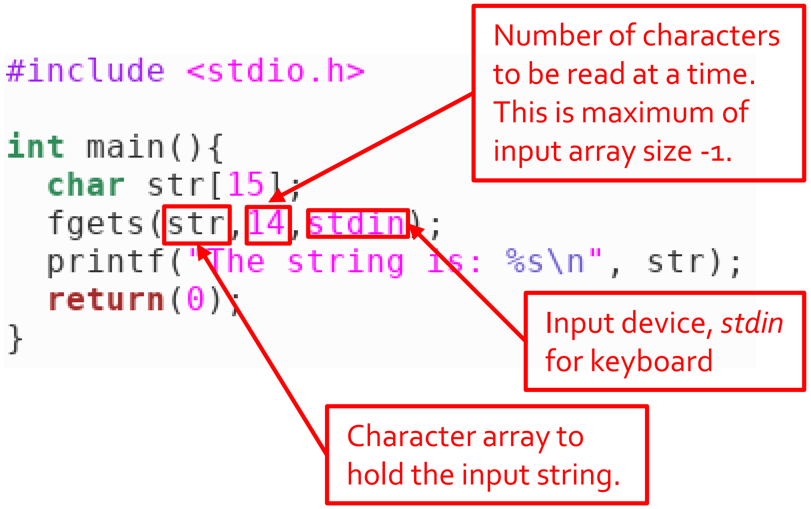
```c
#include <stdio.h>

int main(){
  char str[15];
  gets(str);
  printf("The string is: %s\n", str);
  return(0);
}
```



```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_gets
Nottingham
The string is: Nottingham
[z2019024@CSLinux Strings_LC]$ ./strings_handling_gets
University of Nottingham Ningbo China
The string is: University of Nottingham Ningbo China
Segmentation fault
```

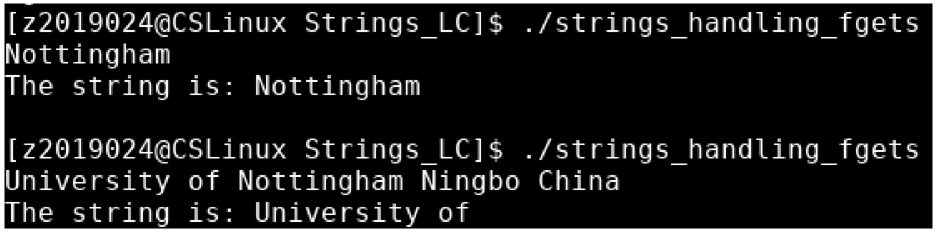
String handling functions cont…

- **fgets()**
  - Input a string from standard keyboard/file line-by-line.
  - It follows some parameters such as Maximum length, buffer, and input device reference.
  - It is safe to use because it checks the array bound.
  - It keeps on reading until a new line character is encountered or the maximum limit of the character array.



```c
#include <stdio.h>

int main(){
   char str[15];
   fgets(str,14,stdin);
   printf("The string is: %s\n", str);
   return(0);
}
```

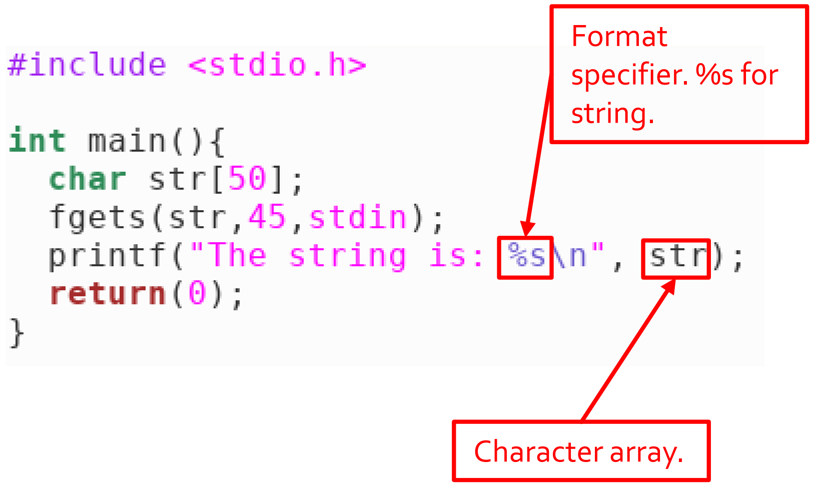
Number of characters to be read at a time. This is maximum of input array size -1.
Input device, *stdin* for keyboard
Character array to hold the input string.



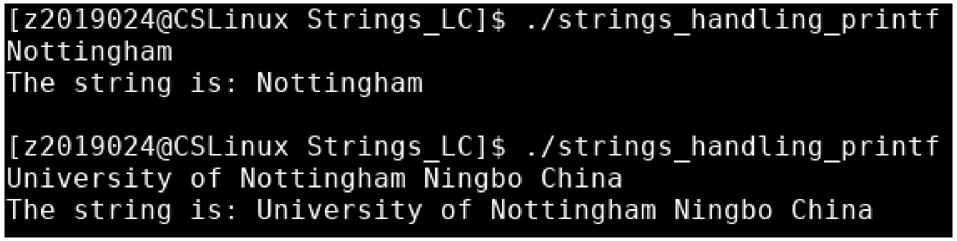
```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_fgets
Nottingham
The string is: Nottingham

[z2019024@CSLinux Strings_LC]$ ./strings_handling_fgets
University of Nottingham Ningbo China
The string is: University of
```

String handling functions cont...

- printf()
  - Print a string including blank space to a standard display.



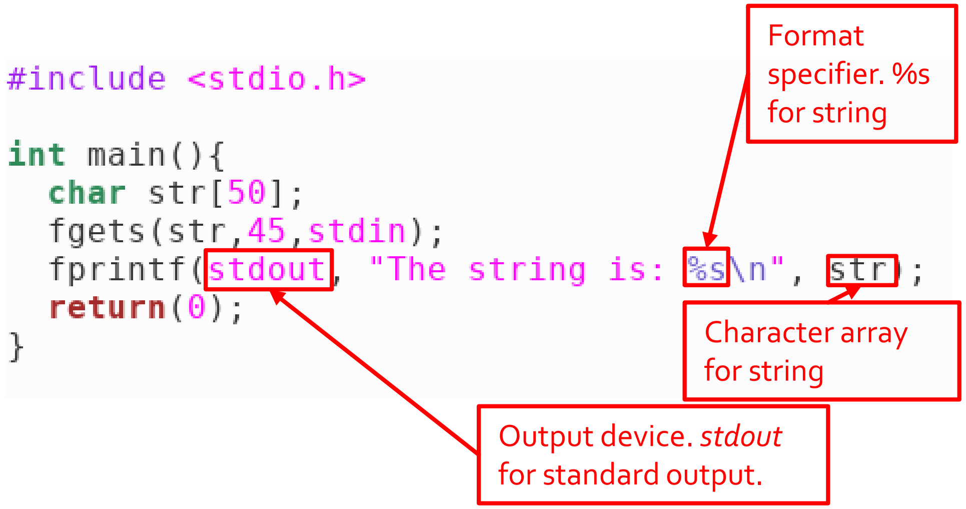
```
#include <stdio.h>

int main(){
   char str[50];
   fgets(str,45,stdin);
   printf("The string is: %s\n", str);
   return(0);
}
```



```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_printf
Nottingham
The string is: Nottingham

[z2019024@CSLinux Strings_LC]$ ./strings_handling_printf
University of Nottingham Ningbo China
The string is: University of Nottingham Ningbo China
```

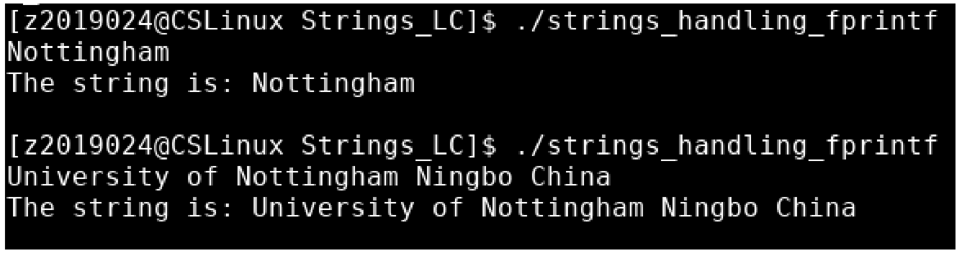
String handling functions cont…

- fprintf()
  - Print a string to a standard display/file



```
#include <stdio.h>

int main(){
  char str[50];
  fgets(str,45,stdin);
  fprintf(stdout, "The string is: %s\n", str);
  return(0);
}
```

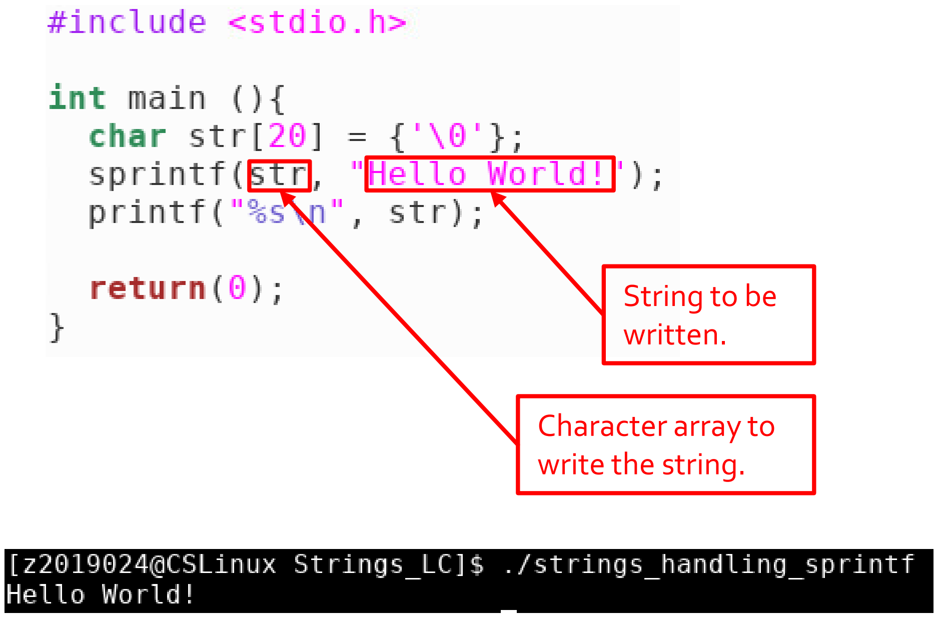
Format specifier. %s for string
Character array for string
Output device. *stdout* for standard output.



```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_fprintf
Nottingham
The string is: Nottingham

[z2019024@CSLinux Strings_LC]$ ./strings_handling_fprintf
University of Nottingham Ningbo China
The string is: University of Nottingham Ningbo China
```

String handling functions cont…

- **sprintf()**
  - Writes a string to another string e.g. array, instead of screen.

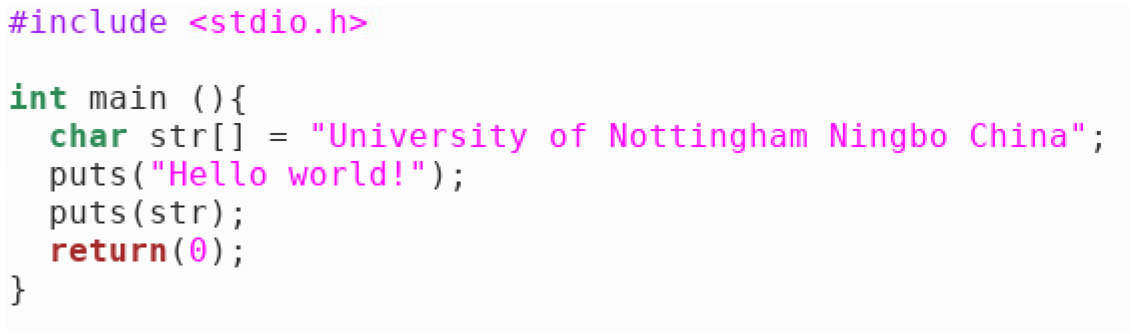


```c
#include <stdio.h>

int main (){
  char str[20] = {'\0'};
  sprintf(str, "Hello World!");
  printf("%s\n", str);

  return(0);
}
```

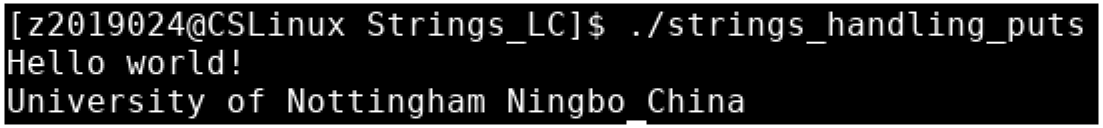
```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_sprintf
Hello World!
```

String handling functions cont…

- **puts()**
  - Print a string to a standard display and add \n at the end of the string.



```c
#include <stdio.h>

int main (){
  char str[] = "University of Nottingham Ningbo China";
  puts("Hello world!");
  puts(str);
  return(0);
}
```



```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_puts
Hello world!
University of Nottingham Ningbo China
```

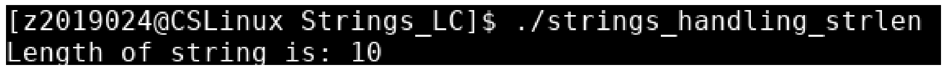
String handling functions cont…

- Basic string operation functions:
  - These functions are inside *string.h* header file. When we use these functions we need to include *string.h* header file in our program.
  - **strlen():** Estimates length of a string.
  - **strcpy() & strncpy():** Copy a source string to a destination string.
  - **strcat() & strncat():** Concatenate two strings.
  - **strcmp() & strncmp():** Compares two strings.
  - **strchr() & strrchr():** Search a character inside a string.
  - **strstr():** Search a string inside another string

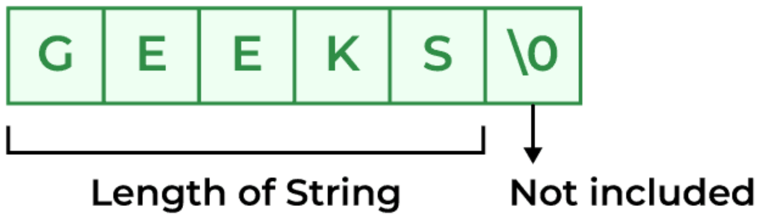
String handling functions cont…

- **strlen()**
  - This function returns the integral length of the string passed.
  - strlen() does not count the NULL character '\o'.

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

int main (){
  char str[] = "Nottingham";
  int length = strlen(str);
  printf("Length of string is: %d\n", length);
  return(0);
}
```



```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strlen
Length of string is: 10
```



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String handling functions cont…

- **strcpy():**
  - strcpy() is a C standard library function that copies a string from one location to another.
  - The function takes two arguments: a destination buffer where the copied string will be stored, and a source string that will be copied. The function copies the entire source string, including the null terminator, into the destination buffer.
  - Using this function, you can copy the entire string to the destination string. Source strings are not appended to destination strings. As a result, the content of the destination string is replaced by the content of the source string.
  - Source strings are not affected. After copying, the source string remains the same.
  - In the case of a longer source string (Character Array), strcpy() performs undefined behavior.
- **strncpy():**
  - Copies the first *n* characters of *source* to *destination.*
  - If there is no NULL character among the first n character of src, the string placed in dest will not be NULL-terminated.
  - If the length of *src* is less than *n*, strncpy() writes additional NULL character to *dest* to ensure that a total of *n* character are written.

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

int main (){
   char src[] = "University of Nottingham Ningbo China";
   char dest[100];
   // copying src into dest.
   strcpy(dest, src);
   printf("Copied string: %s\n", dest);
   return 0;
}
```

```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strcpy
Copied string: University of Nottingham Ningbo China
```

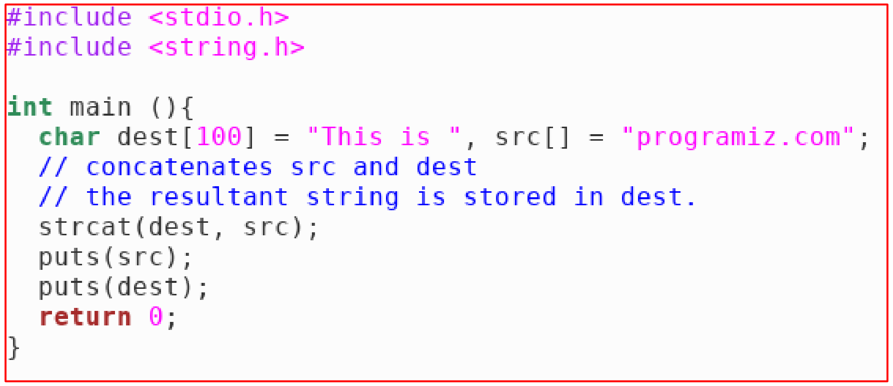
```c
#include <stdio.h>
#include <string.h>

int main (){
   char src[] = "Nottingham";
   char dest[4];
   strncpy(dest, src, 4);
   int len = strlen(dest);
   printf("Copied string: %s\n", dest);
   printf("Length of the destination string: %d\n", len);
   return 0;
}
```

```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strncpy
Copied string: Nott
Length of the destination string: 4
```

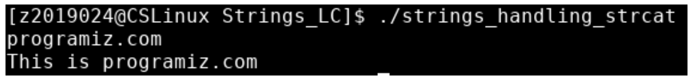
String handling functions cont…

- **strcat():**
  - It will append a copy of the source string in the destination string. plus a terminating Null character.
  - The initial character of the source string overwrites the Null-character present at the end of the destination string.
  - The behavior is undefined if the strings overlap and the dest array is not large enough to append the contents of src.
- **strncat():**
  - This function appends not more than n characters from the source string to the end of the destination string plus a terminating Null-character.
  - The initial character of the source string overwrites the Null-character present at the end of the destination string.
  - Thus, the length of the string(dest) becomes strlen(dest)+n.
  - But, if the length of the string(src) is less than n, only the content up to the terminating null-character is copied and the length of the string(dest) becomes strlen(src) + strlen(dest).
  - The behavior is undefined if the strings overlap and the dest array is not large enough to append the contents of src.

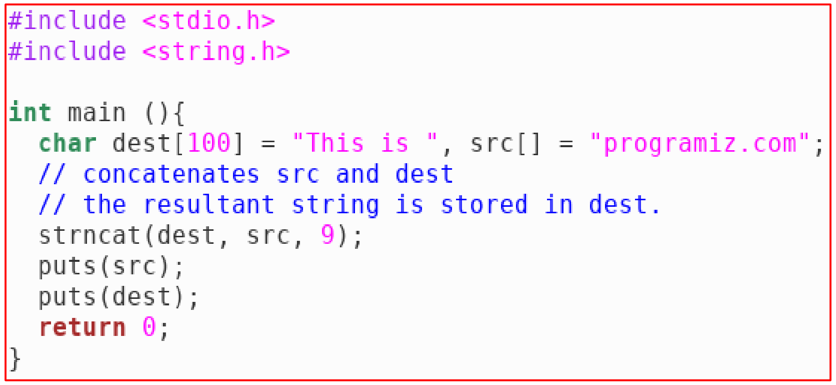


```c
#include <stdio.h>
#include <string.h>

int main (){
  char dest[100] = "This is ", src[] = "programiz.com";
  // concatenates src and dest
  // the resultant string is stored in dest.
  strcat(dest, src);
  puts(src);
  puts(dest);
  return 0;
}
```

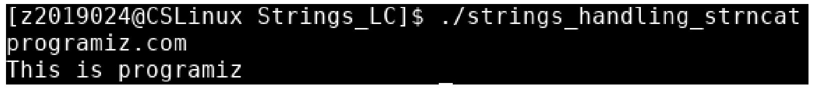


```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strcat
programiz.com
This is programiz.com
```



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

int main (){
  char dest[100] = "This is ", src[] = "programiz.com";
  // concatenates src and dest
  // the resultant string is stored in dest.
  strncat(dest, src, 9);
  puts(src);
  puts(dest);
  return 0;
}
```



```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strncat
programiz.com
This is programiz
```

String handling functions cont…

- **strcmp():**
  - This function takes two strings (array of characters) as arguments, compares these two strings lexicographically.
  - Returns zero if it is the same string.
- **strncmp():**
  - This function lexicographically compares two strings upto *n* characters.
  - Returns zero if the first *n* characters are the same.

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

int main (){
  char leftStr[] = "g f g";
  char rightStr[] = "g f g";
  int res = strcmp(leftStr, rightStr);
  if (res==0)
    printf("Strings are equal");
  else
    printf("Strings are unequal");
  printf("\nValue returned by strcmp() is: %d\n" , res);
  return 0;
}
```

```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strcmp
Strings are equal
Value returned by strcmp() is: 0
```

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

int main (){
  char str1[15];
  char str2[15];
  int ret;
  strcpy(str1, "abcdef");
  strcpy(str2, "abcdpqrs");
  ret = strncmp(str1, str2, 4);
  if(ret == 0)
    printf("four first characters of str1 are equal to str2\n");
  else
    printf("four first characters of str1 are not equal to str2\n");
  return 0;
}
```

```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strncmp
four first characters of str1 are equal to str2
```

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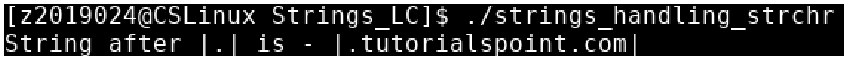
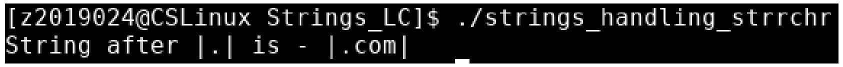
String handling functions cont...

- **strchr():**
  - **char *strchr(const char *str, char c)** searches for the first occurrence of the character c (an unsigned char) in the string pointed to by the argument str.
    - This returns a pointer to the first occurrence of the character c in the string str, or NULL if the character is not found.
- **strrchr():**
  - **char *strrchr(const char *str, char c)** searches for the last occurrence of the character c (an unsigned char) in the string pointed to, by the argument str.
    - This function returns a pointer to the last occurrence of character in str. If the value is not found, the function returns a null pointer.

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

int main (){
  const char str[] = "http://www.tutorialspoint.com";
  const char ch = '.';
  char *ret;
  ret = strchr(str, ch);
  printf("String after |%c| is - |%s|\n", ch, ret);
  return 0;
}
```

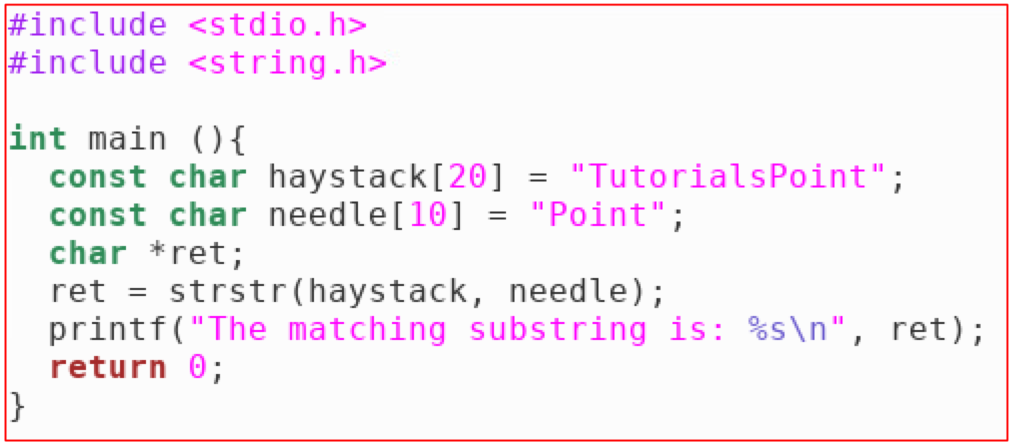
```c
#include <stdio.h>
#include <string.h>

int main (){
  const char str[] = "http://www.tutorialspoint.com";
  const char ch = '.';
  char *ret;
  ret = strrchr(str, ch);
  printf("String after |%c| is - |%s|\n", ch, ret);
  return 0;
}
```


```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strchr
String after |.| is - |.tutorialspoint.com|
```

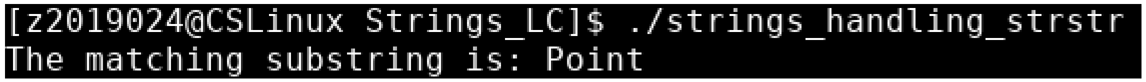

```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strrchr
String after |.| is - |.com|
```

String handling functions cont…

- **strstr():**
  - **char *strstr(const char *A, const char *B)** function finds the first occurrence of the substring “B” in the string “A”. The terminating '\o' characters are not compared.
    - This function returns a pointer to the first occurrence in A of any of the entire sequence of characters specified in B, or a null pointer if the sequence is not present in A.



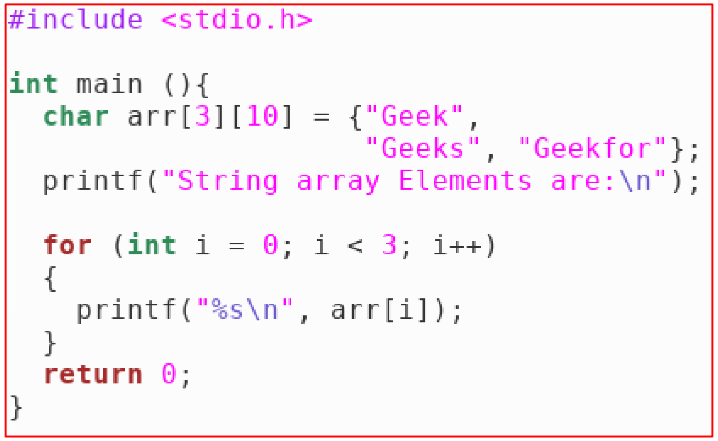
```c
#include <stdio.h>
#include <string.h>

int main (){
   const char haystack[20] = "TutorialsPoint";
   const char needle[10] = "Point";
   char *ret;
   ret = strstr(haystack, needle);
   printf("The matching substring is: %s\n", ret);
   return 0;
}
```



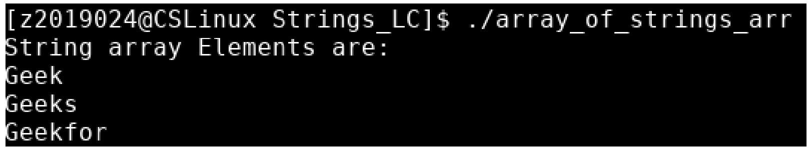
```
[z2019024@CSLinux Strings_LC]$ ./strings_handling_strstr
The matching substring is: Point
```

Array of strings

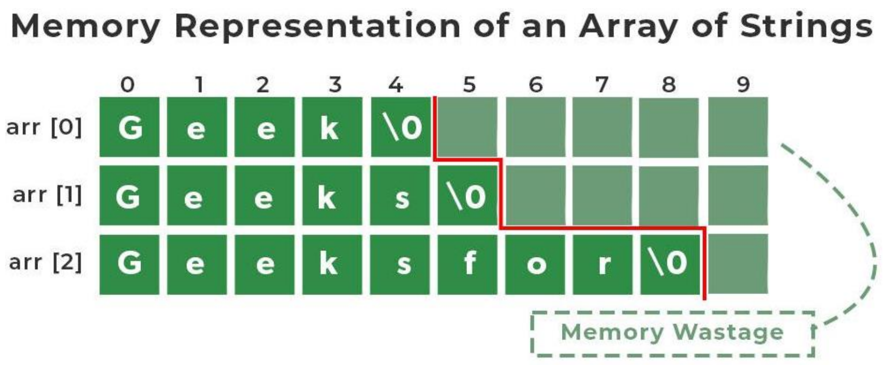
- In C programming String is a 1-D array of characters and is defined as an array of characters. But an array of strings in C is a two-dimensional array of character types. Each String is terminated with a null character (\o). It is an application of a 2d array.



```c
#include <stdio.h>

int main (){
  char arr[3][10] = {"Geek",
                     "Geeks", "Geekfor"};
  printf("String array Elements are:\n");

  for (int i = 0; i < 3; i++)
  {
    printf("%s\n", arr[i]);
  }
  return 0;
}
```



```
[z2019024@CSLinux Strings_LC]$ ./array_of_strings_arr
String array Elements are:
Geek
Geeks
Geekfor
```



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Array of strings cont…

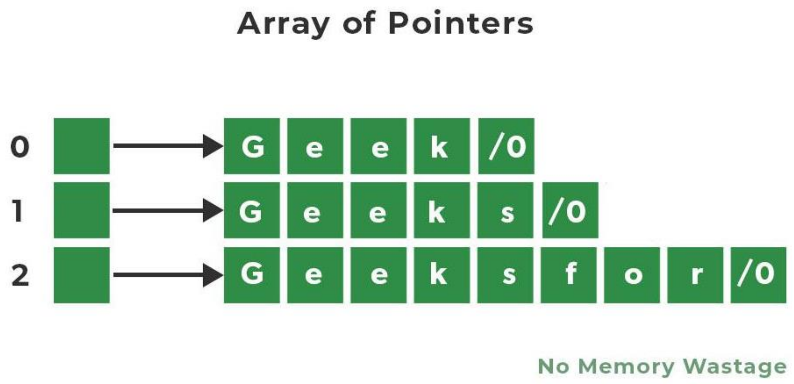
- In C we can use an Array of pointers. Instead of having a 2-Dimensional character array, we can have a single-dimensional array of Pointers. Here pointer to the first character of the string literal is stored.

```
#include <stdio.h>

int main (){
  char *arr[] = {"Geek", "Geeks", "Geekfor"};
  printf("String array Elements are:\n");

  for (int i = 0; i < 3; i++)
  {
    printf("%s\n", arr[i]);
  }
  return 0;
}
```

```
[z2019024@CSLinux Strings_LC]$ ./array_of_strings_ptr
String array Elements are:
Geek
Geeks
Geekfor
```



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Conclusion

- String is a 1-d array of type char.
- A string in C is terminated by '\0' (null character).
- C provides string input and output functions as well as basic string operation functions.
- Pointer can be used to build an array of strings without wastage of memory.

Thank you!