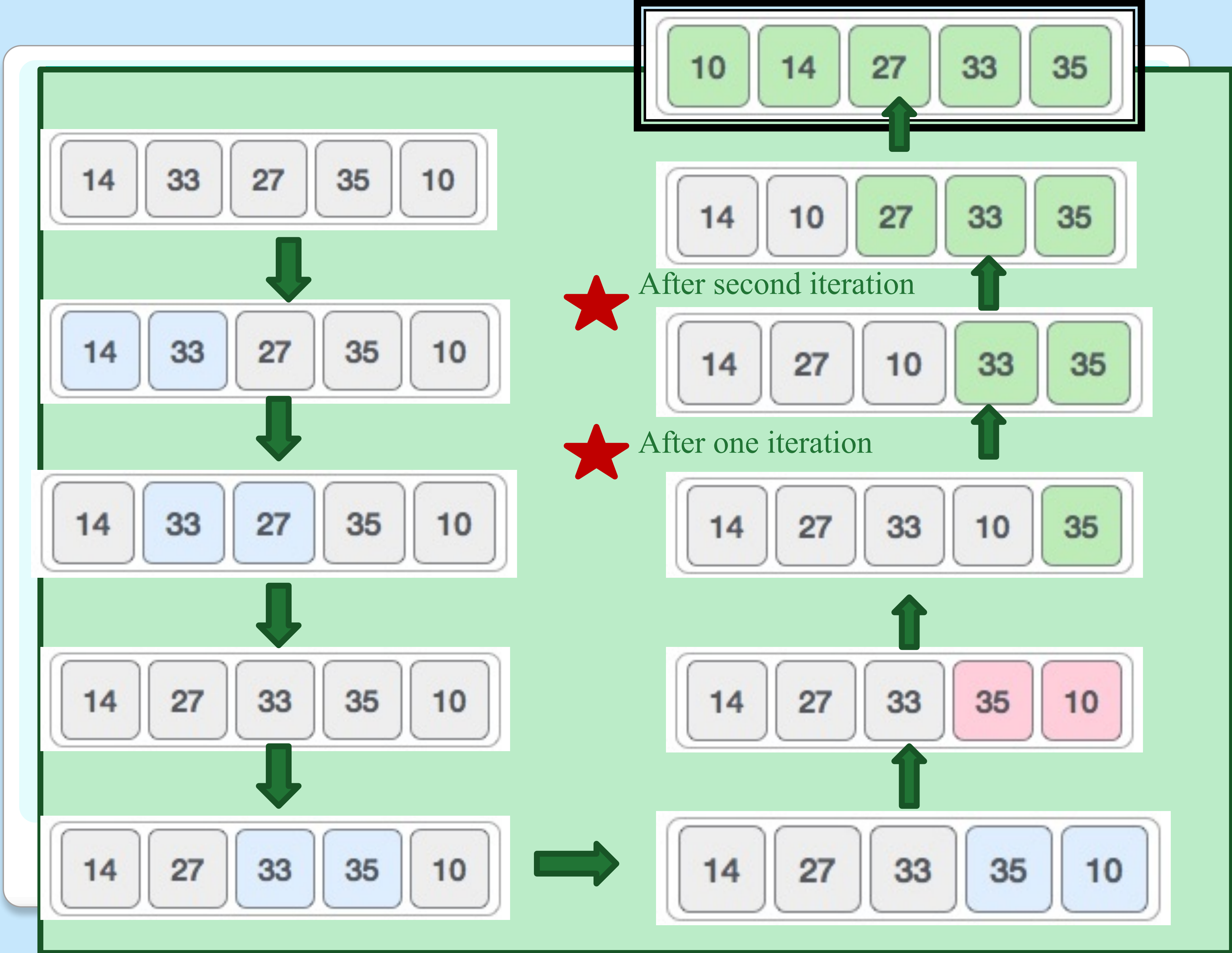
Sorting an array

Bubble sort

- ***A bubble sort compares adjacent array elements*** and exchanges their values if they are out of order.
- Bubble sort is a simple sorting algorithm. **This sorting algorithm is comparison-based algorithm in which each pair of adjacent elements is compared and the elements are swapped if they are not in order.**
- In this way, the smaller values ‘bubble’ to the top of the array (towards element 0), while the larger values sink to the bottom of the array.
- This sort continues until no exchanges are performed in a pass.
- This algorithm is not suitable for large data sets



After one iteration

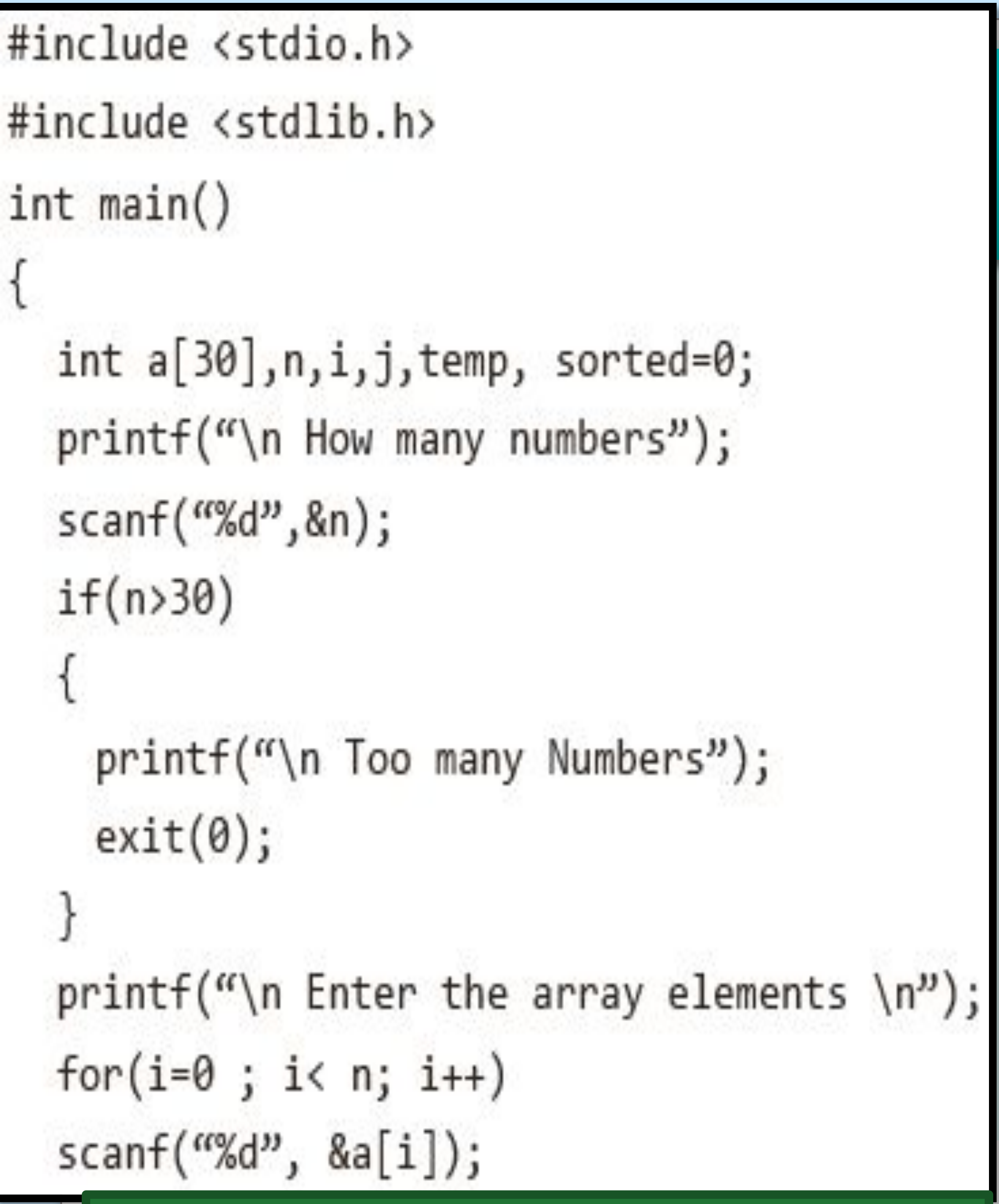
After second iteration

algorithm

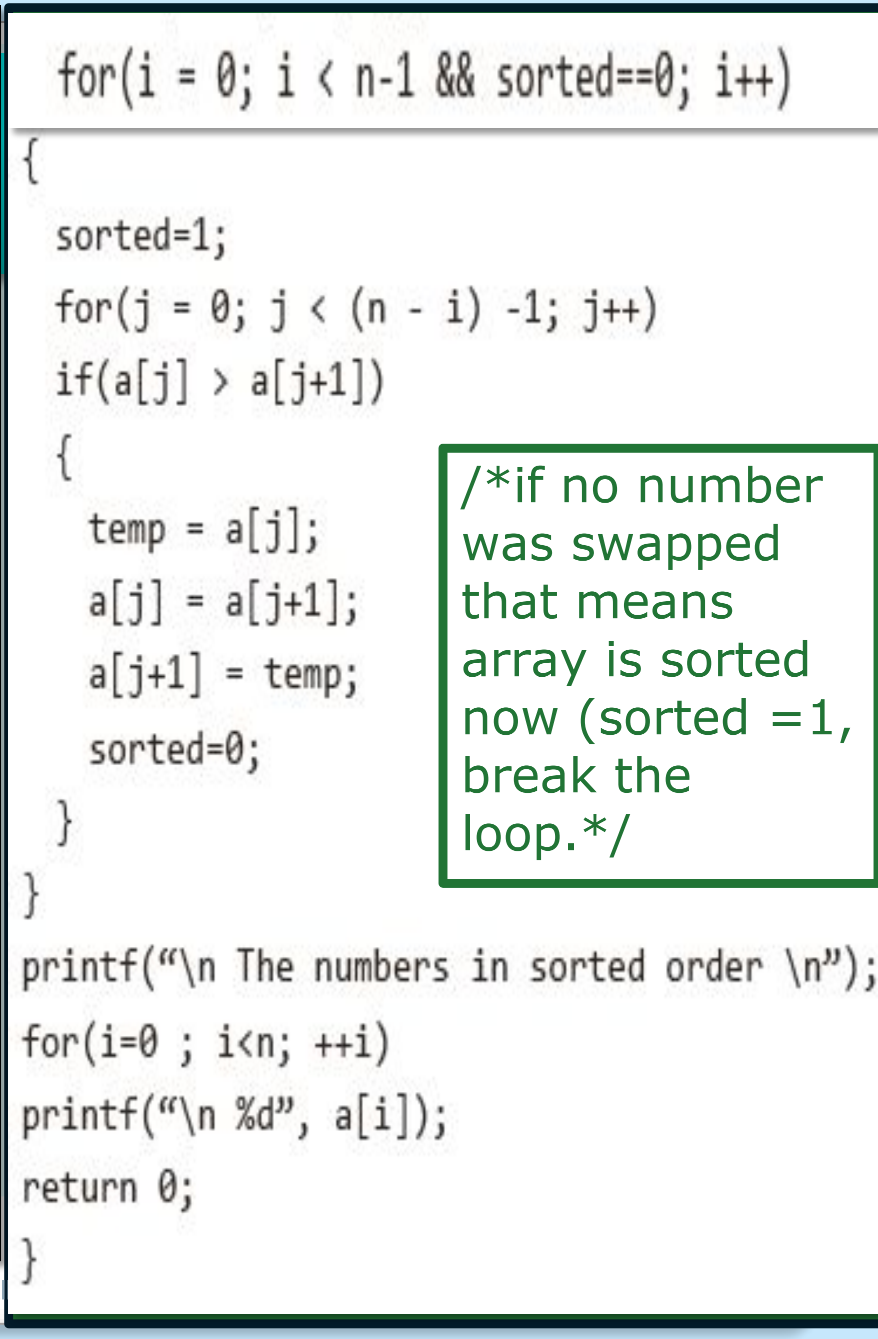
```
for all elements of list (outer for)
  for each element in the list (inner for)
    if list[i] > list[i+1]
    swap(list[i], list[i+1])
    end if
  end for
End for
return list
```

Also , keep a swapped flag so that you know that there is no more swapping in the process. Array is sorted.

Bubble sort



```
#include <stdio.h>
#include <stdlib.h>
int main()
{
  int a[30],n,i,j,temp, sorted=0;
  printf(“\n How many numbers”);
  scanf(“%d”,&n);
  if(n>30)
  {
    printf(“\n Too many Numbers”);
    exit(0);
  }
  printf(“\n Enter the array elements \n”);
  for(i=0 ; i< n; i++)
  scanf(“%d”, &a[i]);
```



```
 for(i = 0; i < n-1 && sorted==0; i++)
{
 sorted=1;
 for(j = 0; j < (n - i) -1; j++)
 if(a[j] > a[j+1])
 {
   temp = a[j];
   a[j] = a[j+1];
   a[j+1] = temp;
   sorted=0;
 }
}
printf(“\n The numbers in sorted order \n”);
for(i=0 ; i<n; ++i)
printf(“\n %d”, a[i]);
return 0;
}
```

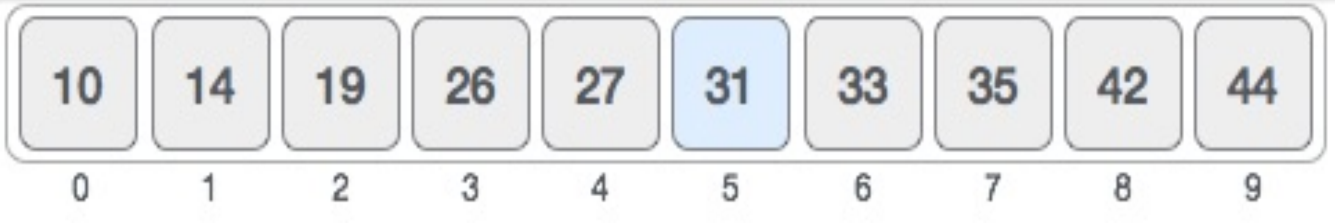
/*if no number was swapped that means array is sorted now (sorted =1, break the loop.*/

Binary Search

- This search algorithm works on the principle of divide and conquer. For this algorithm to work properly, the data should be in the sorted form.
- Binary search looks for a particular item by comparing the middle most item of the collection. If a match occurs, then the index of item is returned.
- If the middle item is greater than the item, then the item is searched in the sub-array to the left of the middle item.
- Otherwise, the item is searched for in the sub-array to the right of the middle item. This process continues on the sub-array as well until the size of the subarray reduces to zero.

Binary search example

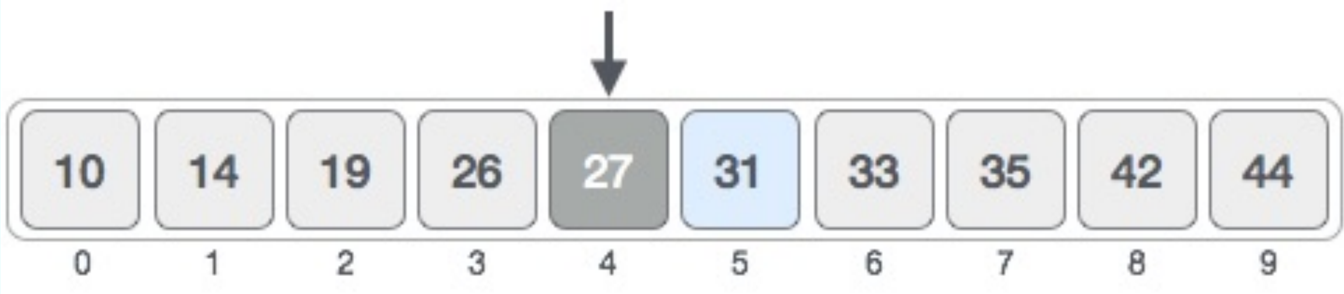
search the location of value 31



10	14	19	26	27	31	33	35	42	44
0	1	2	3	4	5	6	7	8	9

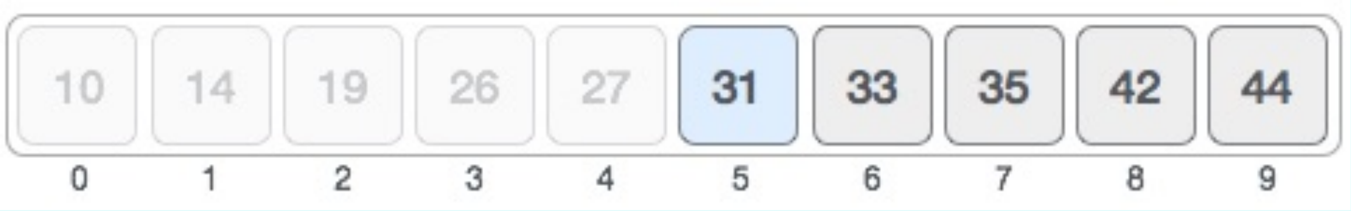
mid = low + (high - low) / 2

We find that the value at location 4 is 27. our number 31 is greater than 27.



10	14	19	26	27	31	33	35	42	44
0	1	2	3	4	5	6	7	8	9

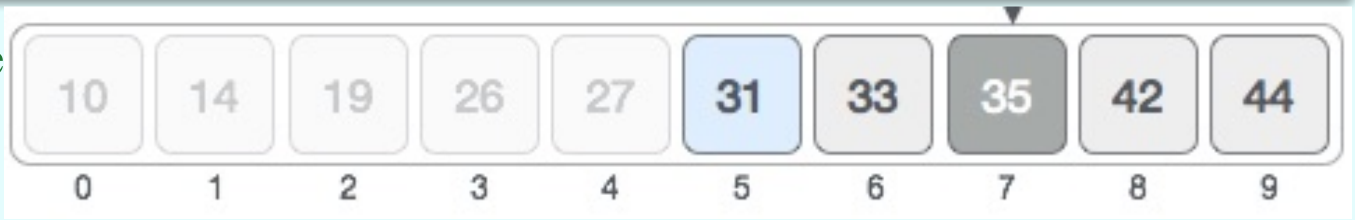
Now we consider the right half of the array only.



10	14	19	26	27	31	33	35	42	44
0	1	2	3	4	5	6	7	8	9

Binary search example contd.

Set new low and ne mid

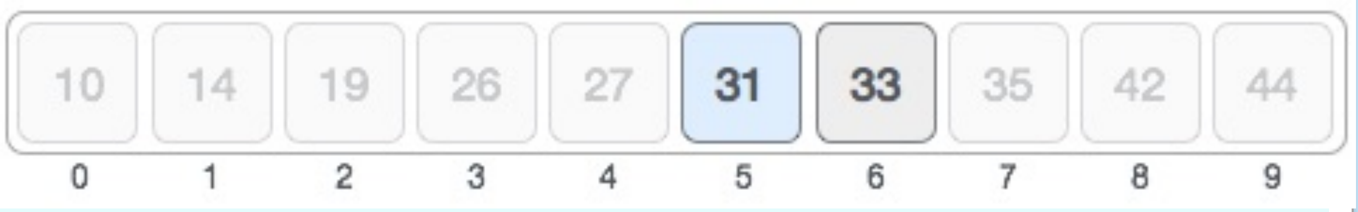


10	14	19	26	27	31	33	35	42	44
0	1	2	3	4	5	6	7	8	9

As mid number 35 is greater than 31, then the value must be in the lower part.

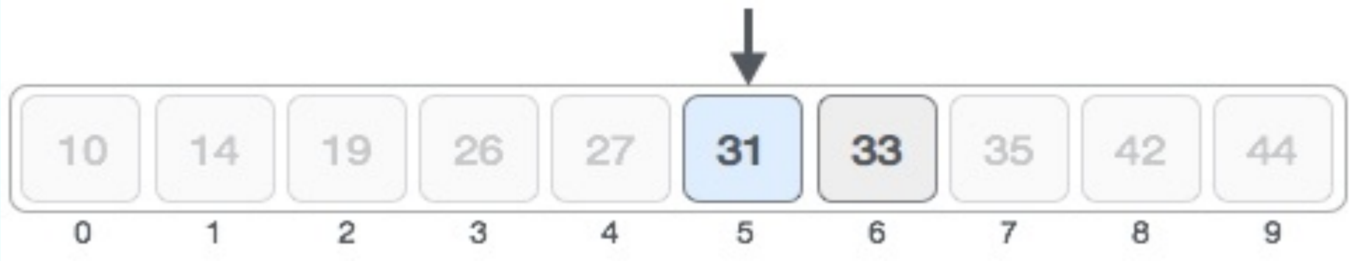
low = mid + 1

mid = low + (high - low) / 2



10	14	19	26	27	31	33	35	42	44
0	1	2	3	4	5	6	7	8	9

Hence, we calculate the mid again. This time it is 5. Match is found



10	14	19	26	27	31	33	35	42	44
0	1	2	3	4	5	6	7	8	9

We conclude that the target value 31 is stored at location 5.

Pseudocode

```
A ← sorted array
n ← size of array
x ← value to be searched
Set lowerBound = 1
Set upperBound = n
while x not found
        if upperBound < lowerBound
       EXIT: x does not exists.
       set midPoint = lowerBound + ( upperBound - lowerBound ) / 2
        if A[midPoint] < x
                set lowerBound = midPoint + 1
        if A[midPoint] > x
               set upperBound = midPoint – 1
        if A[midPoint] = x
                EXIT: x found at location midPoint
end while
```

```
#include <stdio.h>
 int main()
{ int c, first, last, middle, n, key,
array[100];
printf("Enter number of
elements\n");
scanf("%d",&n);

printf("Enter %d integers\n",
n);
for (c = 0; c < n; c++)
scanf("%d",&array[c]);

printf("Enter value to find\n");
scanf("%d", &key);

 first = 0;
last = n - 1;
 middle = (first+last)/2;
```

```
while (first <= last)
{
if (array[middle] < key)
      first = middle + 1;
else if(array[middle] == key)
{
      printf("%d found at
location %d.\n", key,
middle+1);
      break;
}
else
last = middle - 1;

middle = (first + last)/2;
}
if (first > last)
 printf("Not found! %d is not
present in the list.\n", key);
return 0;
}
```

Note

- Single operations, which involve entire arrays, are not permitted in C.
- Neither can all elements of an array be set at once nor can one array be assigned to another.
- For an array of length L and data type X, the compiler allocates L* sizeof (X) bytes of contiguous space in memory.
- char = 1 byte; int = 2 bytes ; float = 4 bytes;
- Note the arrays

char array_nr1[40]; 40*sizeof(char) = 40 bytes

→

int array_nr1[10]; 10*sizeof(int) = 20 bytes

int array_nr2[10]; 10*sizeof(float) = 40 bytes

STRINGS: ONE-DIMENSIONAL CHARACTER ARRAYS

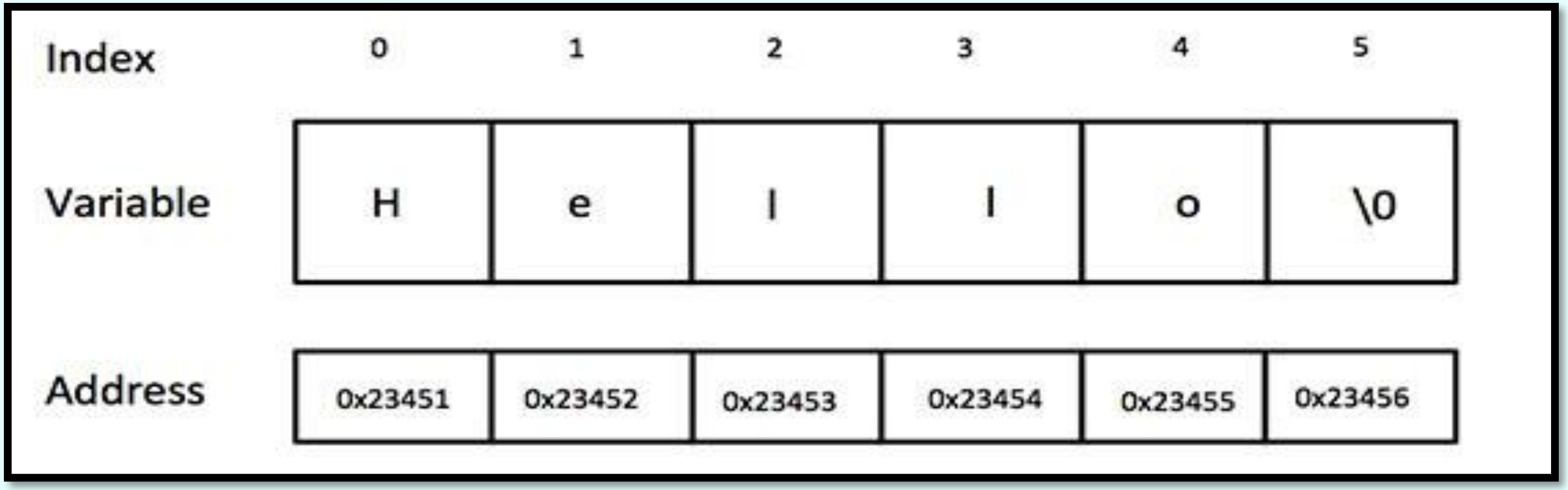
- Strings in C are represented by **arrays of characters**. **The end of the string is marked with a special character.**

  In the *ASCII* character set, the null character value is 0. The null or string-terminating character is represented by another character escape sequence, \0.

- **Strings are actually one-dimensional array of characters terminated by a null character '\0'. Thus a null-terminated string contains the characters that comprise the string followed by a null.**

Declaration of A String

char greeting[6] = {'H', 'e', 'l', 'l', 'o', '\0'};



Index	0	1	2	3	4	5
Variable	H	e	l	l	o	\0
Address	0x23451	0x23452	0x23453	0x23454	0x23455	0x23456

The C compiler automatically places the '\0' at the end of the string when it initializes the array

Declaration of A String

- Strings can be declared like one-dimensional arrays.
  - For example,
    char str[30];
    char text[80];

- An array formed by characters is a string in C.
- **The end of the string is marked with a the null** character.
- **When the character array size is explicitly specified** and the number of initializers completely fills the array size, the null character is not automatically appended to the array.

Initiation of a string

```
char s[]=“Hello, World”;
```

Printing Strings

- The conversion type 's' may be used for output of strings using printf().
- The following points should be noted.
  - When the field width is greater than the length of the string, the entire string is printed.
  - The integer value on the right side of the decimal point specifies the number of characters to be printed.
  - When the number of characters to be printed is specified as zero, nothing is printed.
  - The minus sign in the specification causes the string to be printed as left justified.

Example

```
#include <stdio.h>
int main()
{
char s[]=“Hello, World”;
printf(“>>%s<<\n”,s);
printf(“>>%20s<<\n”,s);
printf(“>>%-20s<<\n”,s);
printf(“>>%.4s<<\n”,s);
printf(“>>%-20.4s<<\n”,s);
printf(“>>%20.4s<<\n”,s);
return 0;
}
```

output

```
>>Hello, World<<
>>Hello, World<<
>>Hello, World<<
>>Hell<<
>>Hell<<
>> Hell<<
```

String INPUT/OUTPUT

- One special case, where the null character is not automatically appended to the array**, is when the array size is explicitly specified and the number of initializers completely fills the array size.**
- char nonterminated[5] = "12345‟;

- printf() with the width and precision modifiers in the %s conversion specifier may be used to display a string.

- The %s format does not require the ampersand before the string name in scanf().

String INPUT/OUTPUT

- If fewer input characters are provided, scanf() hangs until it gets enough input characters.
- scanf() only recognizes a sequence of characters delimited by white space characters as an external string.
- The library function sprintf() is similar to printf().
- The C library function sprintf () is used to store formatted data as a string.
- You can also say the sprintf () function is used to create strings as output using formatted data.
- The only difference is that the formatted output is written to a memory area rather than directly to a standard output.

Enter your Name and Print

```
#include <stdio.h>
int main()
{
      char buffer[50];
      int a = 15, b = 25, res;
      res = a + b;
      sprintf(buffer, "The Sum of %d and %d is %d", a, b,
res);
      printf("%s", buffer);
      return 0;
}
```

Enter your Name and Print

```
#include <stdio.h>
int main()
{
    char str[50];
    printf("Enter a string : ");

    //Option 1 to read and print string
    scanf("%[^\n]s",str);
    printf("You entered: %s", str);


    return(0);
}
```

Enter your Name and Print

```
#include<stdio.h>
int main()
{
    char string[20];
    printf("Enter the string: ");
    fgets(string,20,stdin);          #input from stdin stream
    printf("\nThe string is: %s",string);
    return 0;
}
```

isupper()

```
#include <stdio.h>
#include <ctype.h>
int main()
{ int var1 = 'M';
int var2 = 'm';
char ch = ‘g’
if( isupper(var1) )
{
    printf("var1 = |%c| is uppercase character\n", var1 );
}
else
{
   printf("var1 = |%c| is not uppercase character\n", var1 );
}
printf("var1 = |%c| is in uppercase character\n", toupper(ch)
   );
return 0;
}
```

toupper()

```
#include <stdio.h>
#include <ctype.h>
int main()
{ char c; c = 'm';
   printf("%c -> %c", c, toupper(c));
/*Displays the same argument passed if other characters
   than lowercase character is passed to toupper()*/.
c = 'D';
printf("\n%c -> %c", c, toupper(c));
c = '9';
printf("\n%c -> %c", c, toupper(c));
return 0;
}
```

```
m -> M
D -> D
9 -> 9
```

fscanf & fprintf

fprintf(FILE *stream, const char *format, ...) sends formatted output to a stream.

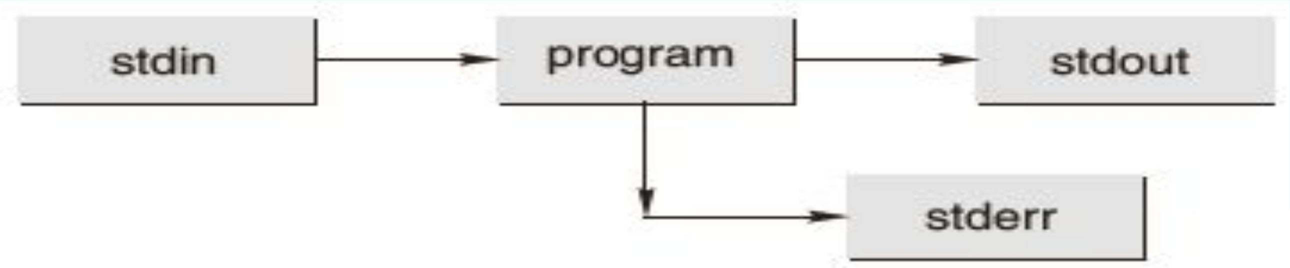
```
fprintf(fp, "%s %s %s %d", "We", "are", "in", 2012);
```

fscanf(FILE *stream, const char *format, ...) reads formatted input from a stream.

```
fscanf(fp, "%s %s %s %d", str1, str2, str3, &year);
```

String input and output using fscanf() and fprintf()

- stdin, stdout, and stderr: Each C program has three I/O streams.
  - The input stream is called standard-input (stdin); the output stream is called standard-output (stdout); and the side stream of output characters for errors is called standard error (stderr).
  - Now one might think that calls to fprinf() and fscanf() differ significantly from calls to printf() and scanf().
  - fprintf() sends formatted output to a stream and fscanf() scans and formats input from a stream.



Standard input and output

Standard File	File Pointer	What is happening
Standard input	stdin	Standard input is stream data (often text) going into a program (data transfers by use of the *read* operation)
Standard output	stdout	Standard output is the stream where a program writes its output data(data transfer with the *write* operation)
Standard error	stderr	Another output stream typically used by programs to output error messages. It is a stream independent of standard output and can be redirected separately

See the following example

```
#include <stdio.h>
int main()
{
int first, second;

fprintf(stdout,“Enter two inputs in this line: ”);
fscanf(stdin,“%d %d”, &first, &second);

fprintf(stdout,“Their sum is: %d.\n”, first + second);
return 0;
}
```

String Manipulation

- C has the weakest character string capability of any general-purpose programming language.
- Strictly speaking, there are no character strings in C, just arrays of single characters that are really small integers.
- If s1 and s2 are such ‘strings’ a program cannot
  - Assign one to the other: s1 = s2;
  - Compare them for collating sequence: s1 < s2;
  - Concatenate them to form a single longer string: s1 + s2;
  - Return a string as the result of a function.

String Manipulation

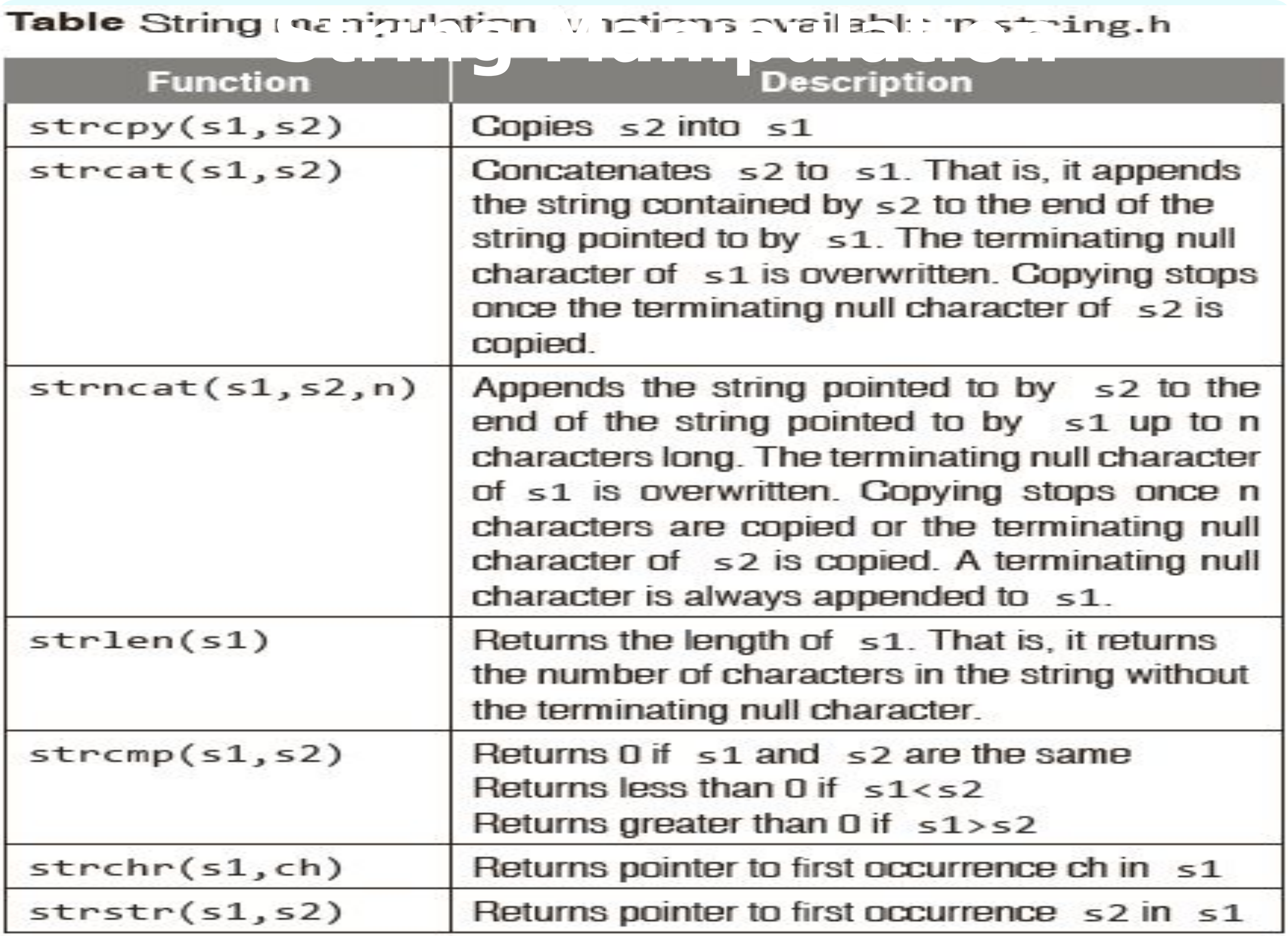


Table String manipulation functions available in string.h

Function	Description
`strcpy(s1,s2)`	Copies s2 into s1
`strcat(s1,s2)`	Concatenates s2 to s1. That is, it appends the string contained by s2 to the end of the string pointed to by s1. The terminating null character of s1 is overwritten. Copying stops once the terminating null character of s2 is copied.
`strncat(s1,s2,n)`	Appends the string pointed to by s2 to the end of the string pointed to by s1 up to n characters long. The terminating null character of s1 is overwritten. Copying stops once n characters are copied or the terminating null character of s2 is copied. A terminating null character is always appended to s1.
`strlen(s1)`	Returns the length of s1. That is, it returns the number of characters in the string without the terminating null character.
`strcmp(s1,s2)`	Returns 0 if s1 and s2 are the same Returns less than 0 if s1<s2 Returns greater than 0 if s1>s2
`strchr(s1,ch)`	Returns pointer to first occurrence ch in s1
`strstr(s1,s2)`	Returns pointer to first occurrence s2 in s1

Copying a String into another

- Since C never lets entire arrays to be assigned, the strcpy() function can be used to copy one string to another.
  - strcpy() copies the string pointed to by the second parameter into the space pointed to by the first parameter.
  - The entire string, including the terminating NUL, is copied and there is no check that the space indicated by the first parameter is big enough.
  - The given code shows the use of the strcpy(str1, str2) function.

strcpy()

```
#include<string.h>
#include<stdio.h>
int main()
{
char s1[] ="Hello, world!";
char s2[20];
strcpy(s2, s1);
printf("%s",s2);
return 0;
}
```

Finally
Mid-sem is over!

puts() and gets()

The C library function **puts(str)** writes a string to stdout up to but not including the null character. A newline character is appended to the output.

The C library function **gets (str)** reads a line from stdin and stores it into the string. It stops when either the newline character is read or when the end-of-file is reached, whichever comes first.

```
#include <stdio.h>
int main()
{
   char str[50];
   printf("Enter a string : ");
   gets(str);
\\fgets(str, sizeof(str), stdin);

   printf("You entered: %s",
   str);
   return(0);
}
```

Comparing strings

- strcmp() takes the start addresses of two strings as parameters and returns the **value zero** if the strings are equal.

  declaration

  int strcmp(char *str1, char *str2)

- if Return value < 0 then it indicates str1 is less than str2.
- if Return value > 0 then it indicates str2 is less than str1.
- if Return value = 0 then it indicates str1 is equal to str2.

- Each character is compared in turn an a decision is made as to whether the first or second string is greater, based on that character (ASCII value).
- Only if the characters are identical do you move to the next character and, if *all* the characters were identical, zero is returned.

strcmp()

```c
#include <stdio.h>
#include <string.h>
int main ()
{
    char str1[15];
    char str2[15];
    int ret;

    strcpy(str1, "abcdef");
    strcpy(str2, "ABCDEF");

    ret = strcmp(str1, str2);
    if(ret < 0)
    {
        printf("str1 is less than str2");
    }
    else if(ret > 0)
    {
        printf("str2 is less than str1");
     }
    else
    {
        printf("str1 is equal to str2");
    }
     return(0);
}
```

```
str2 is less than str1
```

//strcmp will give a positive number if the first string is greater

Comparing strings

- Since C never lets entire arrays to be assigned, the strcpy() function can be used to copy one string to another.
- Strings can be compared by the help of strcmp() function.
- The arithmetic addition cannot be applied for joining two or more strings; this can be done by using the standard library function, strcat().

Putting strings together strcat()

char strcat(dest, src)

Parameters

dest -- This is (pointer to) the destination array, which should contain a C string, and should be large enough to contain the concatenated resulting string.

src -- This is the string to be appended. This should not overlap the destination.

This function returns (a pointer to the) resulting string dest.

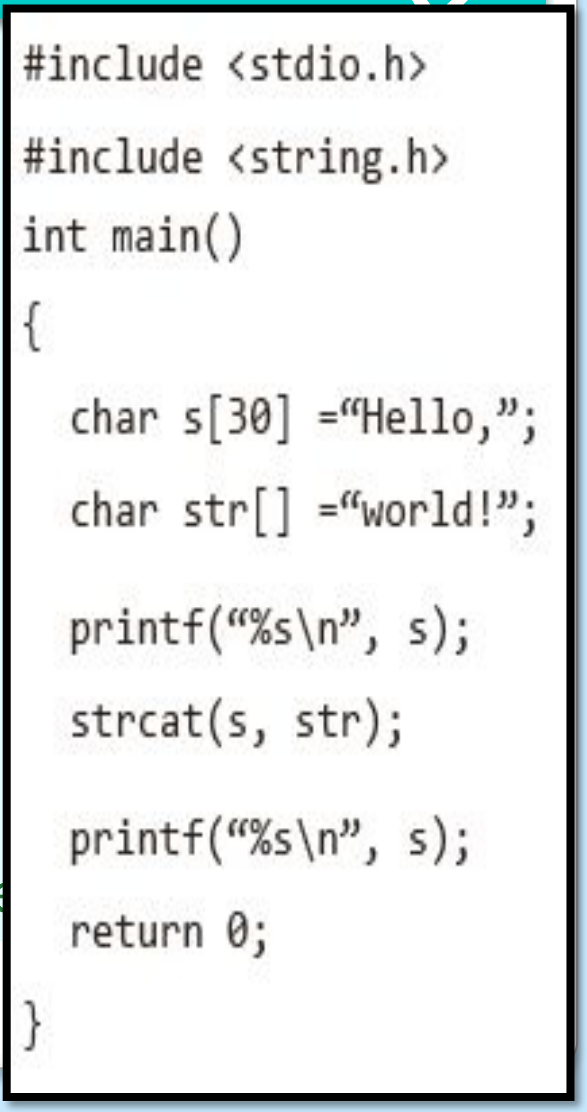
String concatenation

```
#include <stdio.h>
int main()
{
char string1[20];
char string2[20];

strcpy(string1, “Welcome");
strcpy(string2, “ToPCclass");

printf("Returned String : %s\n", strcat( string1, string2 ));
printf("Concatenated String : %s\n", string1 );
return 0;
 }
```

```
Returned String : WelcomeToPCclass
Concatenated String : WelcomeToPCclass
```

Putting strings together strcat()

- The arithmetic addition cannot be applied for joining of two or more strings in the manner
  - string1 = string2 + string3; or
  - string1 = string2 +”RAJA”;
  - For this, the standard library function, strcat(), that concatenates strings is needed. It does not concatenate two strings together and give a third, new string.
  - In this example, the first call to printf prints “Hello,”, and the second one prints “Hello, world!”, indicating that the contents of str have been appended to the end of s.



```
#include <stdio.h>
#include <string.h>
int main()
{
   char s[30] =“Hello,”;
   char str[] =“world!”;

   printf(“%s\n”, s);
   strcat(s, str);

   printf(“%s\n”, s);
   return 0;
}
```

Programs on strings

- WAP to find the reverse of a string by using library function for reverse operation.
- WAP to replace all occurrences of a character in a given string with a new character.

Reverse a string

PROGRAM CODE

```
#include<stdio.h>
#include<string.h>
int main()
{
char s[100]; revs[100]
printf("\nEnter a string : ");
gets(s);
revs = strrev(s);
printf("\nThe reverse of the string is %s ", revs)
return 0 ;
}
```

```
RUN-1
Enter a String : I am good.
The reverse of the string is .doog
ma I
RUN-1
Enter a String : How are you?
The reverse of the string is
?uoy era woH
```

Reverse a string – without library function

PROGRAM CODE

```
#include<stdio.h>
#include<string.h>
int main()
{
char s[100];
int l, i;

printf("\nEnter a string : ");
gets(s);
l=strlen(s);

printf("\nThe reverse of the string is ");
for(i=l-1; i>=0; i--)
printf(“%c”, s[i]);
return 0;
}
```

INPUT/ OUTPUT

RUN-1

```
Enter a String : I am good.
The reverse of the string is .doog
ma I
```

RUN-1

```
Enter a String : How are you?
The reverse of the string is
?uoy era woH
```

Replace a char

PROGRAM CODE

```
#include<stdio.h>
#include<string.h>
int main()
{
char s[100], och, nch;
int i, flag=0;
printf(“\nEnter a string :”);
gets(s);
printf(“\nEnter a character :”);
scanf(“%c”, &och);
printf(“\nEnter the new character :”);
scanf(“ %c”, &nch)//add a space
for(i=0; s[i]!=’\0’; i++)
{
     if(s[i]==och)
     {
          s[i]=nch;
          flag=1;
     }
}//for loop ends here
if(flag==1)
printf("\nAfter the replacement by new
character, the string is %s”, s;);
else
printf("\nThe given string does not
contain the character %c”, och);
return 0;
}
```

INPUT/OUTPUT

RUN-1

```
Enter a string: Bachelor of
Engineering

Enter a character: e

Enter a new character: A

After the replacement by
new character, the string is
BachAlor of EnginAAring
```