CS 101: Computer Programming and Utilization

15-Strings

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Predict the output of this program

```
int main() {
  char s1[10] = {'H', 'e', 'l', 'l', 'o', '\0', 'a', 'b', 'c', 'd'};
  char s2[] = "Hello";
  char *s3 = "Hello";

        cout << s1 << s2 << s3 << endl;
        cout << s1[1] << s2[1] << s3[1] << endl;
        cout << *s1 << *s2 << *s3 << endl;
}
// Run: demo15-strings.cpp
```

Strings

We routinely use strings of characters to represent words, so it is important to to handle such data in our programs.

- A string constant is a sequence of zero or more characters enclosed in double quotes - “Hello”
- We have already used these in cout statements.
- Recall – what is the difference between
  - cout << “Hello”;
  - cout << “Hello\n”;
  - cout << “Hello” << endl;

Representation of Strings

char- basic data type can contain only one character

Strings are a sequence of characters

- Use an array of char to represent strings
- char s[20]; //Avoid using - char s[] or char *s;
- Characters of a string are in consecutive elements - s[0] = ‘H’ s[1] = ‘e’ s[2] = ‘l’ s[3] = ‘l’ s[4] = ‘o’
- How will we know when a string has ended?
  - Put an artificial sentinel character at the end - \0
  - C++ automatically assigns \0 at the end when
  - we declare char s[] = “Hello”;
  - or when we read it from input as cin >> s2;

Activity – Reverse a string

Think (individually): Write down the steps involved in reversing a string.

Pair (with neighbour): Write program to read a string, reverse it, and then output the reversed string.

Share: Compare with next slide.

Reversing a string – without using libraries

```
int main() {
char s1[100], temp; int i = 0, j = 0;
cout<<"Enter a string (without spaces) : "; cin>>s1;


  for (j = 0; s1[j] != '\0'; j++) ; //Find length of string in j
   while(i < j/2) {
      temp=s1[i]; s1[i]=s1[j-i-1];
      s1[j-i-1]=temp; i++;
   } cout<<"Reverse string is : "<<s1<<endl;
} // Run: demo15-strings.cpp
```

C - String functions

There is no data type called 'string' in C. A string is simply an array of characters terminated by the null character '\0';

There is a library of functions for dealing with strings. Its header file is <cstring> or “string.h”

strcpy:	Copy string
strcat:	Concatenate strings
strcmp:	Compare two strings
strchr:	Locate first occurrence of char in string
strrchr:	Locate last occurrence of char in string
strstr:	Locate substring
strlen:	Get string length

http://www.cplusplus.com/reference/cstring/

C++ - The `string` data type

- `cout << “Hello world\n”`
  - “Hello world\n” was stored as an array of characters

- A more modern and better way is to use the `string` data type
- `string msg(“Hello world”);`

- The system manages the array space for us
  - Can assign and append to strings
  - Can read a position: `cout << msg[pos];`
  - Can write a position: `msg[pos] = ‘q’;`

Common `string` operations

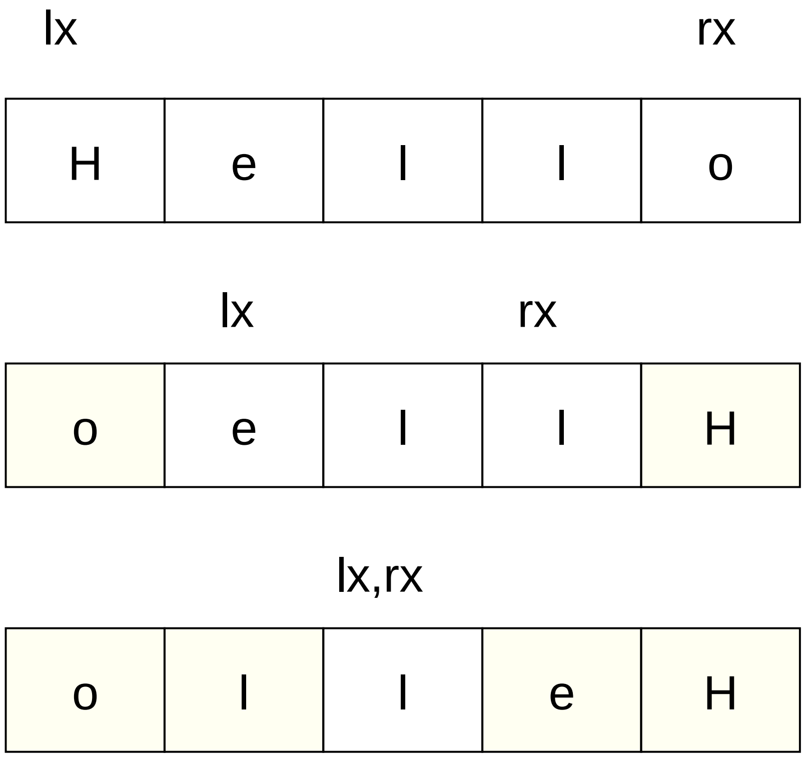
- Get the number of characters in the string
  - `msg.size()`
- Get the character at a specific position
  - `msg.at(5)` or `msg[5]`
- Get a substring of the given string
  - `msg.substr(1, 3)`
- Index out of bound?
  - Some operations throw exceptions
  - Some silently truncate
  - Some may return garbage

Calling a method on a string object

C++ - reversing a string

Using msg.size() and for loop instead of while loop

```
for (int lx=0, rx=msg.size()-1;
  lx < rx; ++lx, --rx) {
   char tmp = msg[lx];
   msg[lx] = msg[rx];
   msg[rx] = tmp;
}
cout << msg;
```



More `string` operations

- Find the first (leftmost) or last (rightmost) occurrence of a character
  - `msg.find_first_of(‘o’)`
  - `msg.find_last_of(‘e’)`
- Compare two strings (dictionary or lexicographic order)
  - `msg1.compare(msg2)`
  - Returns an integer
    - Negative if msg1 should appear before msg2
    - Zero if msg1 and msg2 are equal
    - Positive if msg1 should appear after msg2

// Run: demo15-strings.cpp

C++ String class methods (functions)

size:	Return length of string
length:	Return length of string
clear:	Clear string
empty:	Test if string is empty
at:	Get character in string
operator[]	Get character of string
operator=	Assign to string
operator+=	Append to string
(constructor):	Construct string object
(destructor):	String destructor

http://www.cplusplus.com/reference/string/string

Notes

Switch statement

- `if (cond1) {…} else if (cond2) {…} else if (cond3) {…}` can get tiring
- Common use is to choose between different statements depending on the value of a variable

```
switch (dayOfWeek) {
case 0:
  cout << “Sunday”;
  break;
case 6:
  cout << “Saturday”;
  break;
default:
  cout << “Weekday”;
}
```

Can be `char`, `int`, `long int`

If no `break` here, control will “fall through” to the next case

If none of the listed cases match `dayOfWeek`

Switch: use of break statements

```
int val = 5;
switch (val) {
  case 5:
    cout << "five\n";
    // suppose we forget this break;
  case 4:
    cout << "four\n";
    break;
  default:
    cout << "default\n";
}
```

This statement will be executed even though val is not 4

Switch example

```
switch (ch) {
case 'a': case 'A':
case 'e': case 'E':
case 'i': case 'I':
case 'o': case 'O':
case 'u': case 'U':
  cout << ch << " is a vowel" << endl;
  break;
default:
  cout << ch << " is not a vowel" << endl;
}
```

Can use fall-through as a feature to combine many cases

Another switch example

```
cout << "Enter simple expression: ";
int left;
int right;
char operator;
cin >> left >> operator >> right;
cout << left << " " << operator << " " << right
 << " = ";
switch (operator) {
  case '+' : cout << left + right << endl; break;
  case '-' : cout << left - right << endl; break;
  case '*' : cout << left * right << endl; break;
  case '/' : cout << left / right << endl; break;
  default: cout << "Illegal operation" << endl;
}
```

C String vs C++ String - 1

- A C-string, is an array of characters terminated by the null character '\0'; There is no data type called 'string' in C, but there is a library of functions for dealing with strings represented in this form. Its header file is <cstring> or “string.h”

- A C++ string is an object of the class “string". We need not care about internal representation of the data. The class provides functions for operations on variables of type string. Its header file is <string>

- Both libraries are available to C++ programs
  – functions from C++ string library can be expected to work with C-style strings, but not vice versa.

C String vs C++ String - 2

C-strings (#include <cstring>)	C++ strings (#include <string>)
Declaring a C-string variable	Declaring a C++ string object
char str[10];	string str;
Initializing a C-string variable	Initializing a C++ string object
char str1[11] = "Call home!";	string str1("Call home!");
char str2[] = "Send money!";	string str2 = "Send money!";
char str3[] = {'O', 'K', '\0'};	string str3("OK");
Line above has same effect as:	
char str3[] = "OK";	
	string str4(10, 'x');

C String vs C++ String - 3

Assigning to a C-string variable

Can't do it, i.e., can't do:

```
char str[10];
str = "Hello!";
```

Assigning to C++ string obj

```
string str;
str = "Hello";
str = otherString;
```

Concatenating two C-strings

```
strcat(str1, str2);
strcpy(str, strcat(str1, str2));
```

Concatenating two C++ obj

```
str1 += str2;
str = str1 + str2;
```

Copying a C-string variable

```
char str[20];
strcpy(str, "Hello!");
strcpy(str, otherString);
```

Copying a C++ string object

```
string str;
str = "Hello";
str = otherString;
```

C String vs C++ String - 4

Accessing a single character (C)	Accessing in C++ string
str[index]	str[index]
	str.at(index)
	str(index, count)
Finding the length of a C-string	Length of a C++ string obj
strlen(str)	str.length()
Output of a C-string variable	Output of a C++ string object
cout << str;	cout << str;
Input of a C-string variable	Input of a C++ string object
cin >> s;	cin >> s;
cin.getline(s, numCh+1);	getline(cin, s);
cin.getline(s, numCh+1, 'x');	getline(cin, s, 'x');

Converting between C & C++ Strings

Creating a C++ string object from a C string or string literal:

- Declare the string object and pass the C string or string literal as a constructor argument.

Converting C++ string object to a C string:

- The string class provides a method called c_str() that returns a pointer to the underlying array of characters that holds the contents of the string. The C string returned by this method can not be modified, but it can be used, printed, copied, etc.

```
char s1[20];
string s2 = "My C++ string";
strcpy(s1, s2.c_str());   // Copies C string "My C++ string" into s1
```

- Use C++ strings whenever possible to avoid array errors