• Review

- Copy constructor and assignment
  - What is the prototype for the copy constructor?
  - What is the difference between shallow copy and deep copy?
  - Which copy does the default do?
  - Prototype of the assignment operator
  - What is the main difference between assignment operator and copy constructor?

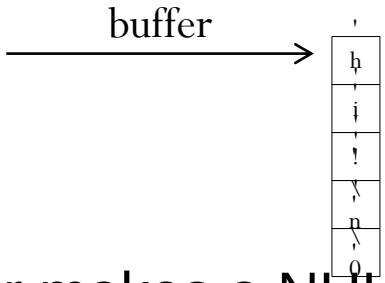
- In Assignment No. 6, in overloading the + operator, what is wrong with the prototype:
  - PlayList operator+(PlayList & p, const song & s);

String and the [] and & operators

C-strings

- Recall that a C-string is implemented as a NULL terminated array of type *char*

```
char buffer[5];
strcpy(buffer,“hi!\n”);
cout<< buffer;
```



- When we use “” the compiler makes a NULL terminated const char array and fills it with the characters the programmer chose
- NOT every char array is a c-string, only those that are NULL terminated
  - Link to c-string review:
    - http://www.cs.fsu.edu/~myers/c++/notes/strings.html

C-string and c++

- We have some features in the standard C++ libraries available to help us work more easily with C-style strings
  - The <cstring> library
    - Contains functions for common string operations, such as copy, compare, concatenate, length, search, tokenization, and more
      - strlen(), strcpy(), strncpy(), strcat(), strncat(), strcmp(), strncmp(), strstr(), strtok()
  - Special features in <iostream>:
    - Special built-in functions for I/O handling of C-style strings, like the insertion and extraction operators, get(), getline(), etc
    - char str1[40];
    - cout << str1; // insertion operator for strings
    - cin >> str1; // extraction, reads up to white space
    - cin.get(str1, 40, ','); // reads to delimiter (comma)
    - cin.getline(sr1, 40); // reads to delimiter (default delimiter is newline), discards // delimiter

The Downside of C-strings

- Fixed length (when declared as static array)
- String name acts like a pointer
- Array bounds are not automatically enforced
- Must use cumbersome functions instead of intuitive operators
  - strcpy(str1, str2); instead of str1 = str2;
  - (strcmp(str1, str2)) instead of (str1 == str2)
  - strcat(str1, str2) instead of str1 += str2;
- The NULL char can be tricky
  - See sample2.cpp, sample3.cpp, sample4.cpp

String Wish List

- We would like a more intuitive string interface
  - str1 + str2 //concatenation
  - str1 == str2 //compare str1 and str2
  - str1 = “Hello!\n” //store “hello!\n” in str1
- We would like to keep some of the legacy functionality
  - str1[4] // returns 4th char in str1
  - str1[4] = 'a' //sets 4th char in str1 to 'a'
  - &str1 returns the c-string (starting address) for str1
- The next programming assignment to be discussed in a while.

Overloading based on L-value and R-value

- An expression such as an array element may happens in the left hand side (lhs) or right hand side (rhs) of an assignment statement.
  - E.g. x= a[2]; a[2] = x;

  - When the expression in the right hand side (x=a[2];): what does the computer needs to know about the expression in order to do the assignment? --- The value
  - When the expression in the right hand side (a[2] = x;), the computer needs to know the memory location of a[2] (not the value of a[2])

  - L-value of a) is the reference of the variablevariable (or expression
  - R-value of a variable is the value of the variable.

Overloading based on L-value and R-value

- Since L-value and R-value are different, C++ allows for overloading operators based on L-value and R-value
  - different functions are invoked depending on whether the operator happens in the left hand side or right hand side of an assignment.

```
Class Someclass {
    public:
        int & operatorX(); // invocated in l-value invocation
        const int & operatorX(); // used in r-value invocation.
    …
};
```

Overloading operator[]

- Usually done with two MEMBER functions
- Format: returntype operator[] (indextype index) const
- returntype& operator[](indextype index)
- The const member function allows us to read the element from a const object
- The non-const member function returns a reference to the element that can be modified
- See sample5.cpp

Overloading the address operator

- The address operator can be overloaded just like any other operator (sample6.cpp)