Unit 12

C++ Strings
Character Arrays

- Recall that in C/C++ string constants (the text in between " ") are just character arrays
  - Each character consumes 1 element in the array
  - Ends with the null character (e.g. 0 decimal or '\0' ASCII)
- This approach of using an array of char's to store a string is referred to as a C-String

```
int main()
{
    char str1[7] = "CS 102"
    /* Initializes the array to "CS 102"*/
    str1[5] = '3'; // now "CS 103"
    cout << str1 << endl;
    // prints "CS 103"
    cin >> str1; // get a new string from the user (suppose user types "hello"
    cout << str1;
}
```

Program Output:
CS 103
hello
C++ Strings

• In C++, the library adds a new object type named **string (C++)** and provides an easier alternative to working with plain-old **character arrays (C-language)**

• Do's and Don'ts
  – Do #include <string>
  – Don't need to declare the size (i.e. [7]), just assign
  – Do still use it like an array by using [index] to get individual characters
  – Do still use cin/cout with strings
  – Don't worry about how many characters the user types when inputting to a C++ string

```cpp
#include <iostream>
#include <string>
using namespace std;

int main()
{
    char str1[7] = "CS 102";
    /* Initializes the array to "CS 102"*/
    string str2 = "CS 102";
    /* Initializes str2 to "CS 102"*/

    str1[5] = '3'; // now str1 = "CS 103"
    str2[5] = '4'; // now str2 = "CS 104"

    cout << str1 << endl;  // prints "CS 103"
    cout << str2 << endl;  // prints "CS 104"

    cin >> str1; // If the user types more than 6 chars..uh oh!
    cin >> str2; // str2 will adjust to hold whatever the user types
}
```
What Do Strings Do

- Strings simply abstract character arrays
- Behind the scenes strings are just creating and manipulating character arrays but giving you a simplified set of operators and functions
- Can concatenate (append) to a string with the `+` operator

```cpp
#include <iostream>
#include <string>
using namespace std;

int main()
{
    string str2 = "CS 102";
    // str2 stores 6 chars. = "CS 102"

    str2 = "Computer Science";
    // now str2 stores 16 characters

    // Can append using '+' or '+=' operator
    str2 = str2 + " is cool";
    // now str2 stores 24 characters
}
```
String Size

- Strings track how many characters they are storing
- Call the `<stringname>.size()` function to get the string's size
  - Returns the actual number of real characters (and does not count overhead like the null character)
String Comparison

- Comparison operators do **not work** with plain old character arrays (C-Strings)
- C++ strings **do** perform lexicographic (alphabetical/dictionary-order) comparison when comparison operators (<, >, ==, etc.) are applied
  - "a" < "z" ? __________
  - "a" < "aa" ? __________
  - "ab" < "ba" ? __________
  - "aab" < "aac" ? __________

```cpp
#include <iostream>
#include <string>
using namespace std;

int main()
{
    char str1[4] = "abc";
    string str2 = "abc";

    if( str1 == "abc" ) // doesn't work
    {
        ...
    }

    if( str2 == "abc" ) // works..true
    {
        ...
    }

    if( str1 < "aac" ) // doesn't work
    {
        ...
    }

    if( str2 < "aac" ) // works..false
    {
        ...
    }

    string str3 = "acb";

    if( str3 > str2 ) // works..true
    {
        ...
    }
}
```
Substrings

- C++ strings allow you to produce a new string from a **substring of a current string**
- Call either of the 2 versions: .substr(start_index) or .substr(start_index, length) function on the string
  - 1\(^{\text{st}}\) version generates substring from starting index location all the way to the end of the string
  - 2\(^{\text{nd}}\) version generates substring from the starting index and includes the next 'length' characters
  - Note: when a function has the **same name but different options for parameters** we say the function is **overloaded**
- Returns a new string
  - Even if length is 1 (i.e. if length is 1 you might think you just get a char, but you still get a string)

```cpp
#include <iostream>
#include <string>
using namespace std;

int main()
{
    string str1 = "CS102";

    string str2 = str1.substr(2);
    // str2 = "102"

    str1 = "Hello World";
    str2 = str1.substr(6,5);
    // str2 = "World"

    str2 = str1.substr(0,1);
    // str2 = "H"
}
```
SOLUTIONS
String Comparison

- Comparison operators do not work with plain old character arrays (C-Strings)
- C++ strings do perform lexicographic (alphabetical/dictionary-order) comparison when comparison operators (<, >, ==, etc.) are applied
  - "a" < "z" ? TRUE
  - "a" < "aa" ? TRUE
  - "ab" < "ba" ? FALSE
  - "aab" < "aac" ? TRUE

```cpp
#include <iostream>
#include <string>
using namespace std;

int main()
{
    char str1[4] = "abc";
    string str2 = "abc";

    if( str1 == "abc" ) // doesn't work
        {...}
    if( str2 == "abc" ) // works..true
        {...}

    if( str1 < "aac" ) // doesn't work
        {...}
    if( str2 < "aac" ) // works..false
        {...}

    string str3 = "acb";
    if( str3 > str2 ) // works..true
        {...}
}
```