friend Functions and friend Classes

friend Function

```
// friend.cpp
// friend functions
#include <iostream>
using namespace std;
/////////////////////////////////////////////////////////////////
class beta;              //needed for frifunc declaration

class alpha
   {
   private:
      int data;
   public:
      alpha() : data(3) {  }            //no-arg constructor
      friend int frifunc(alpha, beta);  //friend function
   };
/////////////////////////////////////////////////////////////////
class beta
   {
   private:
      int data;
   public:
      beta() : data(7) {  }             //no-arg constructor
      friend int frifunc(alpha, beta);  //friend function
   };
/////////////////////////////////////////////////////////////////
int frifunc(alpha a, beta b)            //function definition
   {
   return( a.data + b.data );
   }
//---------------------------------------------------------------
int main()
   {
   alpha aa;
   beta bb;

   cout << frifunc(aa, bb) << endl;     //call the function
   return 0;

   }
```

```
// nofri.cpp
// limitation to overloaded + operator
#include <iostream>
using namespace std;
/////////////////////////////////////////////////////////////////
class Distance                    //English Distance class
   {
   private:
      int feet;
      float inches;
   public:
      Distance() : feet(0), inches(0.0)  //constructor (no args)
         {  }                            //constructor (one arg)
      Distance(float fltfeet)     //convert float to Distance
         {                        //feet is integer part
         feet = static_cast<int>(fltfeet);
             inches = 12*(fltfeet-feet); //inches is what's left
         }
      Distance(int ft, float in)  //constructor (two args)
         { feet = ft; inches = in; }
      void showdist()             //display distance
         { cout << feet << "\'-" << inches << '\"'; }
      Distance operator + (Distance);
   };
//--------------------------------------------------------------
                                  //add this distance to d2
Distance Distance::operator + (Distance d2)   //return the sum
   {
   int f = feet + d2.feet;        //add the feet
   float i = inches + d2.inches;  //add the inches
   if(i >= 12.0)                  //if total exceeds 12.0,
      { i -= 12.0; f++;  }        //less 12 inches, plus 1 foot
   return Distance(f,i);          //return new Distance with sum
   }
////////////////////////////////////////////////////////////////
int main()
   {
   Distance d1 = 2.5;             //constructor converts
   Distance d2 = 1.25;            //float feet to Distance
   Distance d3;
   cout << "\nd1 = "; d1.showdist();
   cout << "\nd2 = "; d2.showdist();

   d3 = d1 + 10.0;                //distance + float: OK
   cout << "\nd3 = "; d3.showdist();
// d3 = 10.0 + d1;                //float + Distance: ERROR
// cout << "\nd3 = "; d3.showdist();
   cout << endl;
   return 0;
   }
```

```
// frengl.cpp
// friend overloaded + operator
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Distance                    //English Distance class
   {
   private:
      int feet;
      float inches;
   public:
      Distance()                  //constructor (no args)
         { feet = 0; inches = 0.0; }
      Distance( float fltfeet )   //constructor (one arg)
         {                        //convert float to Distance
         feet = int(fltfeet);           //feet is integer part
         inches = 12*(fltfeet-feet);    //inches is what's left
         }
      Distance(int ft, float in)  //constructor (two args)
         { feet = ft; inches = in; }
      void showdist()             //display distance
         { cout << feet << "\'-" << inches << '\"'; }
      friend Distance operator + (Distance, Distance); //friend
   };
//--------------------------------------------------------------
Distance operator + (Distance d1, Distance d2) //add D1 to d2
   {
   int f = d1.feet + d2.feet;        //add the feet
   float i = d1.inches + d2.inches;  //add the inches
   if(i >= 12.0)                  //if inches exceeds 12.0,
      { i -= 12.0; f++;   }       //less 12 inches, plus 1 foot
   return Distance(f,i);          //return new Distance with sum
   }
//--------------------------------------------------------------
int main()
   {
   Distance d1 = 2.5;                //constructor converts
   Distance d2 = 1.25;               //float-feet to Distance
   Distance d3;
   cout << "\nd1 = "; d1.showdist();
   cout << "\nd2 = "; d2.showdist();

   d3 = d1 + 10.0;                   //distance + float: OK
   cout << "\nd3 = "; d3.showdist();
   d3 = 10.0 + d1;                   //float + Distance: OK
   cout << "\nd3 = "; d3.showdist();
   cout << endl;
   return 0;
   }
```

friends for functional notation

```
// misq.cpp
// member square() function for Distance
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Distance                    //English Distance class
   {
   private:
      int feet;
      float inches;
   public:                        //constructor (no args)
      Distance() : feet(0), inches(0.0)
         {  }                     //constructor (two args)
      Distance(int ft, float in) : feet(ft), inches(in)
         {  }
      void showdist()             //display distance
         { cout << feet << "\'-" << inches << '\"'; }
      float square();             //member function
   };
//--------------------------------------------------------------
float Distance::square()          //return square of
   {                              //this Distance
   float fltfeet = feet + inches/12;    //convert to float
   float feetsqrd = fltfeet * fltfeet;  //find the square
   return feetsqrd;               //return square feet
   }
////////////////////////////////////////////////////////////////
int main()
   {
   Distance dist(3, 6.0);         //two-arg constructor (3'-6")
   float sqft;

   sqft = dist.square();          //return square of dist
                                  //display distance and square
   cout << "\nDistance = "; dist.showdist();
   cout << "\nSquare = " << sqft << " square feet\n";
   return 0;
   }
```

friend class

```
// friclass.cpp
// friend classes
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class alpha
   {
   private:
      int data1;
   public:
      alpha() : data1(99) {  }   //constructor
      friend class beta;         //beta is a friend class
   };
////////////////////////////////////////////////////////////////
class beta
   {                             //all member functions can
   public:                       //access private alpha data
      void func1(alpha a)  { cout << "\ndata1=" << a.data1; }
      void func2(alpha a)  { cout << "\ndata1=" << a.data1; }
   };
////////////////////////////////////////////////////////////////
int main()
   {
   alpha a;
   beta b;

   b.func1(a);
   b.func2(a);
   cout << endl;
   return 0;

   }
```

Overloading operators

Overloading Binary Operators
Arithmetic operators

```
// englplus.cpp
// overloaded '+' operator adds two Distances
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Distance                    //English Distance class
   {
   private:
      int feet;
      float inches;
   public:                        //constructor (no args)
      Distance() : feet(0), inches(0.0)
         {  }                     //constructor (two args)
      Distance(int ft, float in) : feet(ft), inches(in)
         {  }
      void getdist()              //get length from user
         {
         cout << "\nEnter feet: ";  cin >> feet;
         cout << "Enter inches: ";  cin >> inches;
         }
      void showdist() const       //display distance
         { cout << feet << "\'-" << inches << '\"'; }

      Distance operator + ( Distance ) const;  //add 2 distances
   };
//--------------------------------------------------------------
                                  //add this distance to d2
Distance Distance::operator + (Distance d2) const  //return sum
   {
   int f = feet + d2.feet;        //add the feet
   float i = inches + d2.inches;  //add the inches
   if(i >= 12.0)                  //if total exceeds 12.0,
      {                           //then decrease inches
      i -= 12.0;                  //by 12.0 and
      f++;                        //increase feet by 1
      }                           //return a temporary Distance
   return Distance(f,i);          //initialized to sum
   }
////////////////////////////////////////////////////////////////
int main()
   {
   Distance dist1, dist3, dist4;   //define distances
   dist1.getdist();                //get dist1 from user

   Distance dist2(11, 6.25);       //define, initialize dist2

   dist3 = dist1 + dist2;          //single '+' operator

   dist4 = dist1 + dist2 + dist3;  //multiple '+' operators
                                   //display all lengths
   cout << "dist1 = ";  dist1.showdist(); cout << endl;
   cout << "dist2 = ";  dist2.showdist(); cout << endl;
   cout << "dist3 = ";  dist3.showdist(); cout << endl;
   cout << "dist4 = ";  dist4.showdist(); cout << endl;
   return 0;
   }
```

Unary operators

```
// countpp1.cpp
// increment counter variable with ++ operator
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Counter
   {
   private:
      unsigned int count;              //count
   public:
      Counter() : count(0)             //constructor
         {  }
      unsigned int get_count()         //return count
         { return count; }
      void operator ++ ()            //increment (prefix)
         {
         ++count;
         }
   };
////////////////////////////////////////////////////////////////
int main()
   {
   Counter c1, c2;                     //define and initialize

   cout << "\nc1=" << c1.get_count();  //display
   cout << "\nc2=" << c2.get_count();

   ++c1;                           //increment c1
   ++c2;                           //increment c2
   ++c2;                           //increment c2

   cout << "\nc1=" << c1.get_count();  //display again
   cout << "\nc2=" << c2.get_count() << endl;
   return 0;

   }
```

```
// countpp2.cpp
// increment counter variable with ++ operator, return value
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Counter
   {
   private:
      unsigned int count;      //count
   public:
      Counter() : count(0)     //constructor
```

```
         {  }
      unsigned int get_count() //return count
         { return count; }
      Counter operator ++ ()   //increment count
         {
         ++count;              //increment count
         Counter temp;         //make a temporary Counter
         temp.count = count;   //give it same value as this obj
         return temp;          //return the copy
         }
   };
////////////////////////////////////////////////////////////////
int main()
   {
   Counter c1, c2;                       //c1=0, c2=0

   cout << "\nc1=" << c1.get_count();    //display
   cout << "\nc2=" << c2.get_count();

   ++c1;                                 //c1=1
   c2 = ++c1;                            //c1=2, c2=2

   cout << "\nc1=" << c1.get_count();    //display again
   cout << "\nc2=" << c2.get_count() << endl;
   return 0;
   }
// countpp3.cpp
// increment counter variable with ++ operator
// uses unnamed temporary object
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Counter
   {
   private:
      unsigned int count;          //count
   public:
      Counter() : count(0)         //constructor  no args
         {  }
      Counter(int c) : count(c)    //constructor, one arg
         {  }
      int get_count()              //return count
         { return count; }
      Counter operator ++ ()       //increment count
         {
         ++count;                  //increment count, then return
         return Counter(count);      //  an unnamed temporary object
         }                         //  initialized to this count
   };
////////////////////////////////////////////////////////////////
int main()
   {
   Counter c1, c2;                       //c1=0, c2=0

   cout << "\nc1=" << c1.get_count();    //display
   cout << "\nc2=" << c2.get_count();

   ++c1;                                 //c1=1
   c2 = ++c1;                            //c1=2, c2=2

   cout << "\nc1=" << c1.get_count();    //display again
   cout << "\nc2=" << c2.get_count() << endl;
   return 0;
   }
```

Posfix Notation

```
// postfix.cpp
// overloaded ++ operator in both prefix and postfix
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Counter
   {
   private:
      unsigned int count;         //count
   public:
      Counter() : count(0)        //constructor  no args
         {  }
      Counter(int c) : count(c)   //constructor, one arg
         {  }
      unsigned int get_count() const //return count
         { return count; }

      Counter operator ++ ()      //increment count (prefix)
         {                        //increment count, then return
         return Counter(++count); //an unnamed temporary object
         }                        //initialized to this count

      Counter operator ++ (int)   //increment count (postfix)
         {                        //return an unnamed temporary
         return Counter(count++); //object initialized to this
         }                        //count, then increment count
   };
////////////////////////////////////////////////////////////////
int main()
   {
   Counter c1, c2;                       //c1=0, c2=0

   cout << "\nc1=" << c1.get_count();    //display
   cout << "\nc2=" << c2.get_count();

   ++c1;                                 //c1=1
   c2 = ++c1;                            //c1=2, c2=2 (prefix)

   cout << "\nc1=" << c1.get_count();    //display
   cout << "\nc2=" << c2.get_count();

   c2 = c1++;                            //c1=3, c2=2 (postfix)

   cout << "\nc1=" << c1.get_count();    //display again
   cout << "\nc2=" << c2.get_count() << endl;
   return 0;
   }
```

Comparison Operators

```
// engless.cpp
// overloaded '<' operator compares two Distances
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Distance                    //English Distance class
   {
   private:
      int feet;
      float inches;
   public:                        //constructor (no args)
      Distance() : feet(0), inches(0.0)
         {  }                     //constructor (two args)
      Distance(int ft, float in) : feet(ft), inches(in)
         {  }
      void getdist()              //get length from user
         {
         cout << "\nEnter feet: ";  cin >> feet;
         cout << "Enter inches: ";  cin >> inches;
         }
      void showdist() const       //display distance
         { cout << feet << "\'-" << inches << '\"'; }
      bool operator < (Distance) const; //compare distances
   };
//--------------------------------------------------------------
                                 //compare this distance with d2
bool Distance::operator < (Distance d2) const  //return the sum
   {
   float bf1 = feet + inches/12;
   float bf2 = d2.feet + d2.inches/12;
   return (bf1 < bf2) ? true : false;
   }
////////////////////////////////////////////////////////////////
int main()
   {
   Distance dist1;                 //define Distance dist1
   dist1.getdist();                //get dist1 from user

   Distance dist2(6, 2.5);         //define and initialize dist2
                                   //display distances
   cout << "\ndist1 = ";  dist1.showdist();
   cout << "\ndist2 = ";  dist2.showdist();

   if( dist1 < dist2 )             //overloaded '<' operator
      cout << "\ndist1 is less than dist2";
   else
      cout << "\ndist1 is greater than (or equal to) dist2";
   cout << endl;
   return 0;
   }
```

Arithmetic Assignment operators

```
// englpleq.cpp
// overloaded '+=' assignment operator
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Distance                     //English Distance class
   {
   private:
      int feet;
      float inches;
   public:                         //constructor (no args)
      Distance() : feet(0), inches(0.0)
         {  }                      //constructor (two args)
      Distance(int ft, float in) : feet(ft), inches(in)
         {  }
      void getdist()               //get length from user
         {
         cout << "\nEnter feet: ";  cin >> feet;
         cout << "Enter inches: ";  cin >> inches;
         }
      void showdist() const        //display distance
         { cout << feet << "\'-" << inches << '\"'; }
      void operator += ( Distance );
   };
//--------------------------------------------------------------
                                   //add distance to this one
void Distance::operator += (Distance d2)
   {
   feet += d2.feet;                //add the feet
   inches += d2.inches;            //add the inches
   if(inches >= 12.0)              //if total exceeds 12.0,
      {                            //then decrease inches
      inches -= 12.0;              //by 12.0 and
      feet++;                      //increase feet
      }                            //by 1
   }
////////////////////////////////////////////////////////////////
int main()
   {
   Distance dist1;                 //define dist1
   dist1.getdist();                //get dist1 from user
   cout << "\ndist1 = ";  dist1.showdist();

   Distance dist2(11, 6.25);       //define, initialize dist2
   cout << "\ndist2 = ";  dist2.showdist();

   dist1 += dist2;                 //dist1 = dist1 + dist2
   cout << "\nAfter addition,";
   cout << "\ndist1 = ";  dist1.showdist();
   cout << endl;
   return 0;
   }
```

Data Conversion

Type conversion

Conversion	Routine in Destination	Routine in source
Basic to basic (float to int)	Built in	Built in
Basic to class (int to obj)	Constructor	
Class to Basic (obj to int)		Operator function
Class to class (obj to otherObj	Constructor	Operator function

Conversion between Class and Basic Types

```
// englconv.cpp
// conversions: Distance to meters, meters to Distance
#include <iostream>
using namespace std;
////////////////////////////////////////////////////////////////
class Distance                    //English Distance class
   {
   private:
      const float MTF;            //meters to feet
      int feet;
      float inches;
   public:                        //constructor (no args)
      Distance() : feet(0), inches(0.0), MTF(3.280833F)
         {  }                     //constructor (one arg)
      Distance(float meters) : MTF(3.280833F)
         {                        //convert meters to Distance
         float fltfeet = MTF * meters;  //convert to float feet
         feet = int(fltfeet);           //feet is integer part
         inches = 12*(fltfeet-feet);    //inches is what's left
         }                        //constructor (two args)
      Distance(int ft, float in) : feet(ft),
                                      inches(in), MTF(3.280833F)
         {  }
      void getdist()              //get length from user
         {
         cout << "\nEnter feet: ";  cin >> feet;
         cout << "Enter inches: ";  cin >> inches;
         }
      void showdist() const       //display distance
         { cout << feet << "\'-" << inches << '\"'; }

      operator float() const      //conversion operator
         {                        //converts Distance to meters
         float fracfeet = inches/12;     //convert the inches
         fracfeet += static_cast<float>(feet); //add the feet
         return fracfeet/MTF;            //convert to meters
         }
   };
////////////////////////////////////////////////////////////////
int main()
   {
   float mtrs;
   Distance dist1 = 2.35F;        //uses 1-arg constructor to
                                  //convert meters to Distance
   cout << "\ndist1 = "; dist1.showdist();

   mtrs = static_cast<float>(dist1); //uses conversion operator
                                     //for Distance to meters
   cout << "\ndist1 = " << mtrs << " meters\n";

   Distance dist2(5, 10.25);      //uses 2-arg constructor

   mtrs = dist2;                  //also uses conversion op
   cout << "\ndist2 = " << mtrs << " meters\n";

// dist2 = mtrs;                  //error, = won't convert
   return 0;
   }
```

Conversion between Objects of Different Classes

```
class Cartesian
{
double x;
double y;
public:
Cartesian()
{x=0,y=0)
Cartesian(doubly x, double y)
{
this.x=x
this.y=y
}
//added constructor
Cartesian(Polar p)
{
double r=P.getRadius();
double a=p.getAngle();
x=r*cos(a)
y=r*cos(a)
}
};
class Polar
{
double radius;
double angle;
public:
Polar()
{
radius=0;
angle=0;
}
Polar (double r, double a)
{
radius=r;
angle=a;
}
operator Cartesian()
{
double x=Radius*cos(angle);
double y=radius*sin(angle);
return cartesian(x,y)
}
};
```

In main

```
Polar P(10,.5)
Cartesian c;
c=p
```

Pointer

- Pointers hold a memory address
  - Memory address: long
- Value of memory address is a hexadecimal number
- Declare a pointer
  - int *ptr; //pointer
    EX)
    int x = 10;
    ptr=&x; //=200
    cout<<x; //prints 10
    cout<<&x //prints 200
    cout<<&pts; //shows 100 (address for pointer)
    cout<<ptr; //200
    cout<<*ptr; //10
    x=x+5;
    cout<<x //15
    cout<<*ptr //15

  - ptr returns memory address
  - &ptr returns memory adress for ptr
  - *ptr returns value

- Uninitialized pointer
  int *ptr;
  *ptr = 10; //corrupts the value somewhere in the program
  cout<<*ptr;
- Initialized pointer
  int *ptr;
  int x = 20;
  ptr=&x; //initialize pointer

```
*ptr=10 //ok
cout<<x<<endl; //10
x=x+5;
cout<<*ptr; //15
```

- Null pointer

  ```
  int *ptr=0 //ptr points to nothing
  int *ptr = null; //ptr points to nothing
  int *ptr = nullptr; //only c++ 11
  *ptr =10 //error
  ```

- Reference (variable)
  - Reference is an alias, or an alternative name, to an existing variable
  - Type & refVal = existingVariable

    ```
    int x = 10;
    int &refX = x;
    cout<<x; //10
    cout << &x; //100
    cout<<refX; //10
    cout <<&refX; //100
    ```

- **Reference vs pointer**
  - A reference is a name constant for an address
  - Once a reference is established to a variabe you cannon change the reference to reference another variable

    ```
    int num1=88;
    int num2=22;
    int *ptrnum1 = &num1;
    cout<<*ptrnum1<<endl; //88
    cout<<&ptrnum1;  //300
    cout<<&num1; //100
    cout<<ptrnum1 //100
    ptrnum1=&num2;
    cout<<*ptrnum1; //22
    num1=num+15 //num <---103
    cout<<*ptrnum1; //22
    double z =2.5;
    *ptrnum1=z; //error not int
    int n1=30
    int &refn1=n1;
    cout<<n1; //30
    cout<<refn1; //30
    cout<<&n1; //155
    int n2=5;
    refn1 = &n2 //error, references are constant
    ```

- **Call-by-value**

```
int square (int);
int main()
{
        int number=8;
        cout<<"In main: "<<&number<<endl; //200
        cout<<square(number)<<endl; //64
        cout << number<<endl; //8
}
int square(int n)
{
        cout<< "In Square: "<<&n<<endl; //300
        n*=n;
        return n;
}
```

- **Pass by reference with pointer argument**

```
void square(int *)
int main()
{
        int number=8;
        cout<<"In main: "<<&number<<endl; //100
        square (&number);
        cout<<number;//64
        return 0;
}
void Square (int *n)
{
        cout<<"In Square: "<<n<<endl;//8
        *n = *n  *  *n;
        return ;
}
```

- **Pass by reference with reference argument**

```
int square (int &)
int main()
{
        int number = 8;
        cout<<"In Main: "<<&number<<endl; //100
        cout<<square(number)<<endl; //implicitly
        cout<<number<<endl; //64
        return 0;
}
int square (int &n)
{
        cout<<"in Square: "<<&n<<endl;
        n *= n;
        return n;
}
```

```
}
```

"Const" function reference/pointer parameter

- **A const function parameter cannot be modified in a function. A const function parameter can receive both const and non const arguments**

```
int test (const int);
int main()
{
        int number=8;
        const int n1 = 3;
        cout<<test(number);
        cout<<test(n1);
        return 0;
}

int test (const int n)
{
        n = n*n; //error!
        return n*n;
}
```

- **A non- const function reference/point argument parameter can only receive non-const arguments**

```
int square (int &n)
{
        return n*n;
}
int main ()
{
        int number = 8;
        const int n1=3
        cout<<square(number); //64
        cout<<square(n1); //error, cannot use const
        return 0;
}
//OR
int square (int *n)
{
        return *n * *n;
}
int main ()
{
        int number = 8;
        const int n1 = 3;
        cout<<square(number); //64
        cout<<square(n1); // error
        return 0;
}
```

Const function Reference/pointer parameter

```
    square (const int & n)
    {
        n = n*n //error
        return n*n;
    }
    int main ()
    {
        int number = 8;
        const int n1=3;
        cout << square (number); //64
        cout <<square (n1);//9
        return 0;
    }
```

Pointers and Arrays

```
// arrnote.cpp
// array accessed with array notation
#include <iostream>
using namespace std;

int main()
   {                                         //array
   int intarray[5] = { 31, 54, 77, 52, 93 };

   for(int j=0; j<5; j++)                    //for each element,
      cout << intarray[j] << endl;           //print value
   return 0;

   }
```

```
// array accessed with pointer notation
#include <iostream>
using namespace std;

int main()
   {                                         //array
   int intarray[5] = { 31, 54, 77, 52, 93 };

   for(int j=0; j<5; j++)                    //for each element,
      cout << *(intarray+j) << endl;         //print value
   return 0;

   }
```

```
// passarr.cpp
// array passed by pointer
#include <iostream>
using namespace std;
const int MAX = 5;             //number of array elements
```

```
int main()
   {
   void centimize(double*);  //prototype

   double varray[MAX] = { 10.0, 43.1, 95.9, 59.7, 87.3 };

   centimize(varray);        //change elements of varray to cm

   for(int j=0; j<MAX; j++)  //display new array values
      cout << "varray[" << j << "]="
           << varray[j] << " centimeters" << endl;
   return 0;
   }
//--------------------------------------------------------------
void centimize(double* ptrd)
   {
   for(int j=0; j<MAX; j++)
      *ptrd++ *= 2.54;       //ptrd points to elements of varray
   }
```

C-String manipulation

C++ provides following two types of string representations:

- The C-style character string.
- The string class type introduced with Standard C++.

The C-Style Character String:

The C-style character string originated within the C language and continues to be supported within C++. This string is actually a one-dimensional array of characters which is terminated by a **null** character '\0'. Thus a null-terminated string contains the characters that comprise the string followed by a **null**.

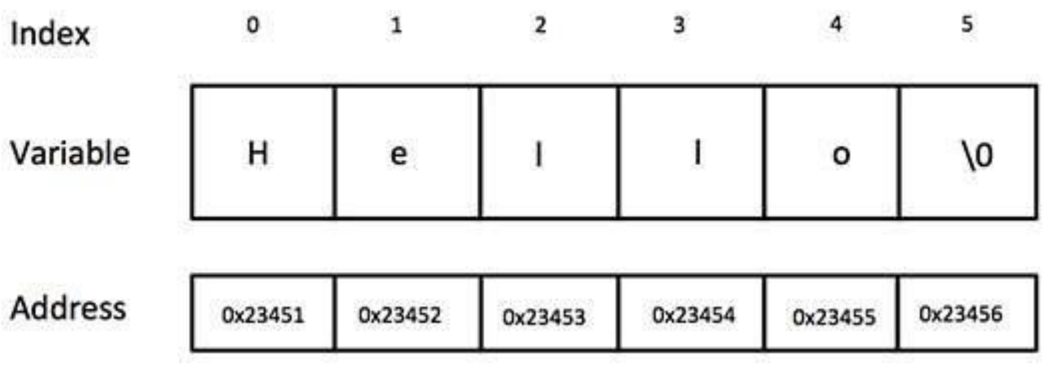
The following declaration and initialization create a string consisting of the word "Hello". To hold the null character at the end of the array, the size of the character array containing the string is one more than the number of characters in the word "Hello."

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

If you follow the rule of array initialization, then you can write the above statement as follows:

```
char greeting[] = "Hello";
```

Following is the memory presentation of above defined string in C/C++:



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

Actually, you do not place the null character at the end of a string constant. The C++ compiler automatically places the '\0' at the end of the string when it initializes the array. Let us try to print above-mentioned string:

```
#include <iostream>

using namespace std;

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

   cout << "Greeting message: ";
   cout << greeting << endl;

   return 0;
}
```

When the above code is compiled and executed, it produces result something as follows:

```
Greeting message: Hello
```

C++ supports a wide range of functions that manipulate null-terminated strings:

	Function & Purpose
1	**strcpy(s1, s2);** Copies string s2 into string s1.
2	**strcat(s1, s2);** Concatenates string s2 onto the end of string s1.
3	**strlen(s1);** Returns the length of string s1.
4	**strcmp(s1, s2);**

Returns 0 if s1 and s2 are the same; less than 0 if s1<s2; greater than 0 if s1>s2.

5 **strchr(s1, ch);**

Returns a pointer to the first occurrence of character ch in string s1.

6 **strstr(s1, s2);**

Returns a pointer to the first occurrence of string s2 in string s1.

Following example makes use of few of the above-mentioned functions:

```
#include <iostream>
#include <cstring>

using namespace std;

int main ()
{
   char str1[10] = "Hello";
   char str2[10] = "World";
   char str3[10];
   int  len ;

   // copy str1 into str3
   strcpy( str3, str1);
   cout << "strcpy( str3, str1) : " << str3 << endl;

   // concatenates str1 and str2
   strcat( str1, str2);
   cout << "strcat( str1, str2): " << str1 << endl;

   // total lenghth of str1 after concatenation
   len = strlen(str1);
   cout << "strlen(str1) : " << len << endl;

   return 0;
}
```

When the above code is compiled and executed, it produces result something as follows:

```
strcpy( str3, str1) : Hello
strcat( str1, str2): HelloWorld

strlen(str1) : 10
```

C string manipulation

Write a function that returns the number of digits in a given null-terminated string.

```
#include<iostream>
#include<cctype>
using namespace std;
int numAlphas(const char* s)
{
        int count = 0;
        for (int i = 0; s[i] != '\0'; i++)
        {
                if (isdigit(s[i]))
                {
                        count++;
                }
        }
        return count;
}

int main()
{
        char str[] = "a12bc3d";
        cout << numAlphas(str);

}
```

C Strings and Pointers

```
// Create your own strlen function
#include <iostream>
using namespace std;
int myStrLen(char str[]);

int main()
{
        char s[15] = "Hello World";
        cout << myStrLen(s);
        return 0;
}
//---------------------------------------------------------------
int myStrLen(char str[])
{
        int i = 0;
        while (str[i] != '\0')
                i++;
        return i;
}
```

Or

```
int myStrLen(char *str)
{
        char *first = str;
        while (*str != '\0')
                str++;
        return str - first;
}
```

Or

```
int myStrLen(char *str)
{
        char *first = str;
        while (*str)
                str++;
        return str - first;

}
```

```
// create your own strcpy function
#include <iostream>
using namespace std;
void myStrcpy(char str2[], char str1[]);

int main()
{
        char s1[15] = "Hello World";
        char s2[30];
        myStrcpy(s2, s1);
        cout << s2;
        return 0;
}
//-----------------------------------------------------------
void myStrcpy(char *to, char * from)
{
        while (*to = *from)
        {
                to++;
                from++;
        }

}
```

Or

```
void myStrcpy(char *to, char * from)
{
        while (*to++ = *from++);

}
```