Chapter 5
Functions

Learning Objectives

- Use of functions in C++
- Simple functions
- Passing arguments to functions
- Create function overloads
- Recursion
- Write and use inline functions
- Default Arguments
- Variables and Storage Class

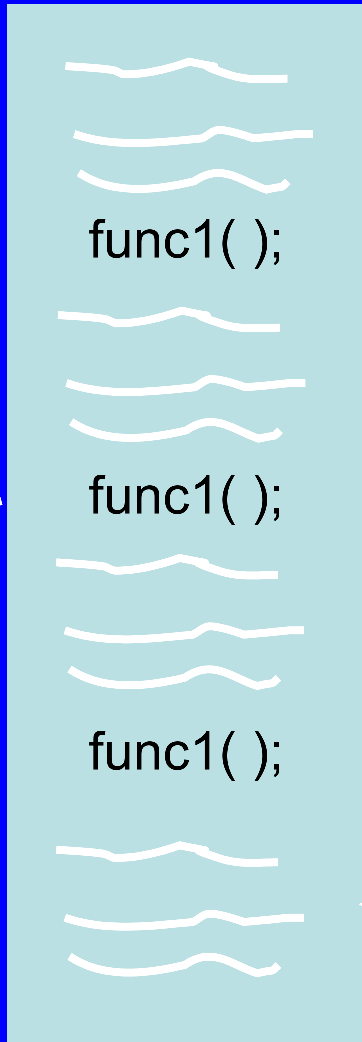
FUNCTIONS

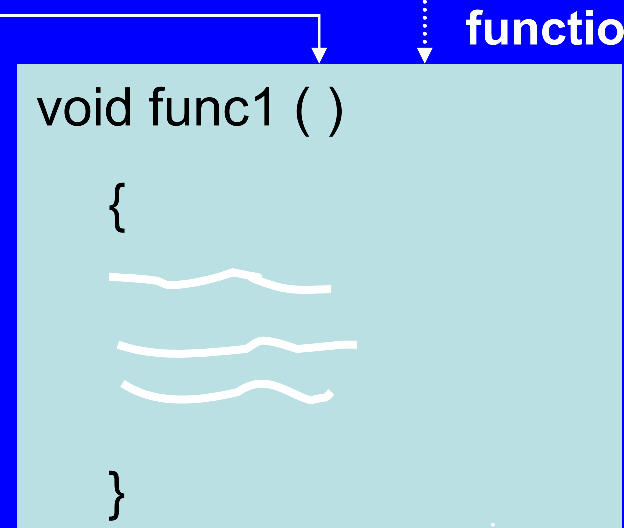
- A function groups a number of program statements into a unit and gives it a name
- This unit can be invoked from other parts of the program

Use of Function

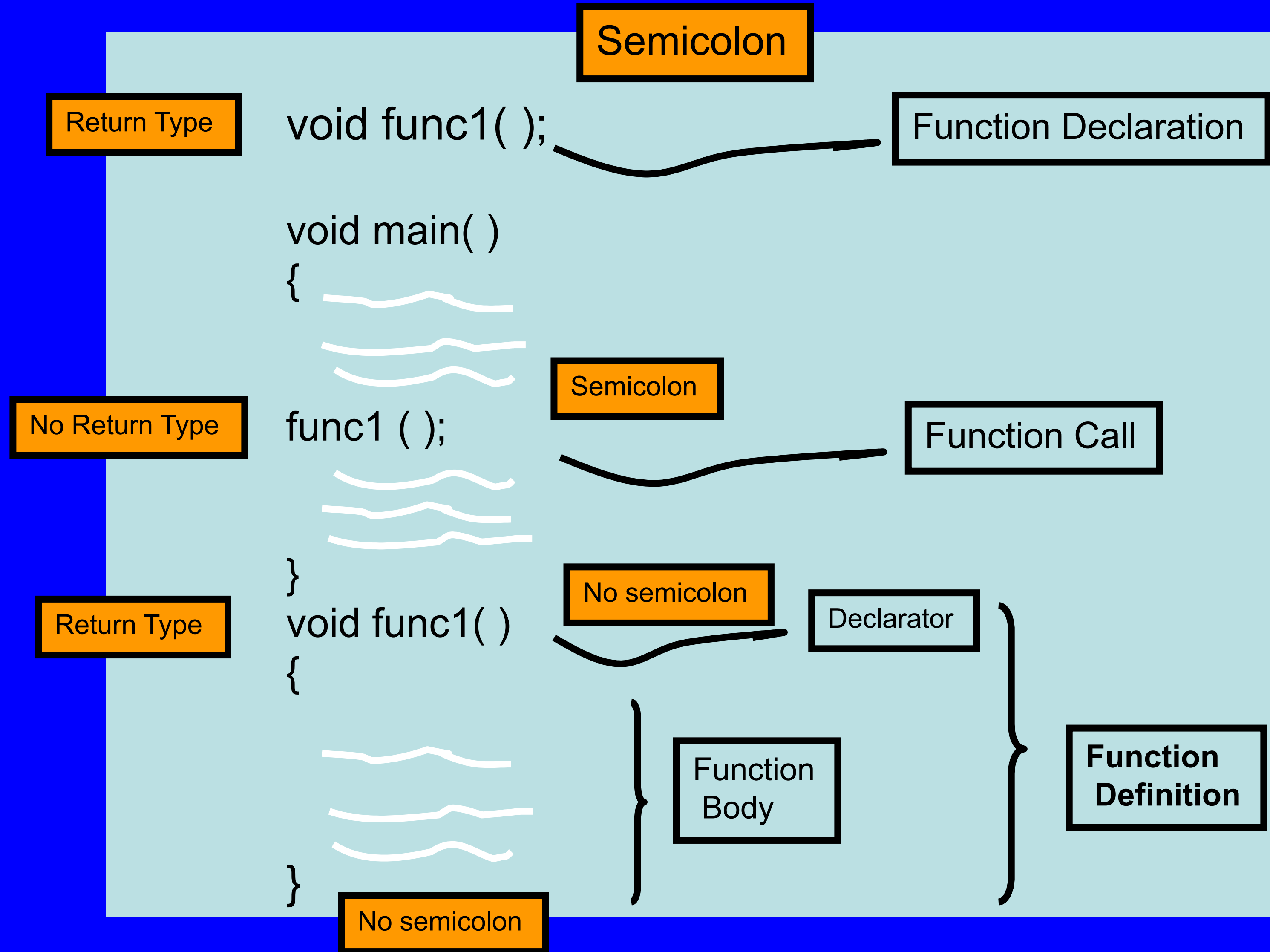
- To aid in the conceptual organization of a program
- To reduce program size

FUNCTIONS





Simple Functions



Function Definition

It contains the actual code of function

```
int ftoc (int temp)
{
        int result= (temp-32)*5/9;
        return result;
}
```

<u>Function Definition Format</u>

```
returntype  functionname (parameterlist)
  {
        Statements;
  }
```

parameterlist contains type and name of variables used in the function

FUNCTION EXAMPLE

```
// table.cpp
// demonstrates simple function
#include <iostream.h>

void starline();                    //function declaration

int main()
{
    starline();                                         //call to function
    cout << "Data type  Range" << endl;
    starline();                                         //call to function
    cout << "char   -128 to 127" << endl
         << "short  -32,768 to 32,767" << endl
         << "int      System dependent" << endl
         << "long    -2, 147, 483, 648 to 2,147, 483, 647" << endl;
    starline();                                         //call to function
return 0;
}
```

Cont…..

FUNCTION EXAMPLE

```
//…………………………………………
//starline()
//function definition
    void starline()          //function declarator
    {
        for(int j=0; j<45; j++)  //function body
        cout << '*';
        cout << endl;
    }
```

Simple Functions Contd..

- Comparison with Library Functions
  - The declaration is in the header file specified at the beginning of the program
  - The definition (compiled into executable code) is in a library file that is linked automatically
- Eliminating the Declaration
  - Place the definition (the function itself) in the beginning of program before the first call to the function

Eliminating the Declaration Example

```
// table2.cpp
// demonstrates function definition preceding function calls
#include <iostream.h>
                                  //no function declaration
//...............................
// starline()                      //function definition
void starline()
{
for(int j=0; j<45; j++)
cout << '*';
cout << endl;
}
//............................................
int main()                        //main() follows function
{
starline();                       //call to function
cout << "Date type Range" << endl;
starline();                       //call to function
cout << "char                     -128 to 127" << endl
       << "short                  -32, 768 to 32, 767" << endl
       << "int                    System dependent" << endl
       << "long                   -2, 147, 483, 648 to 2, 147, 483, 647" << endl;
starline();                       //call to function
return 0;
}
```

Passing Arguments to Function

- Constants
- Expressions
- Variables
  - By value
  - By reference

Passing Arguments to Functions Contd..

- The parameter of function are initialized to the value of argument passed to it
- Function create copies of the arguments passed to it, is called passing by value
- Passing other types of arguments
  - Pointers and arrays
  - Structures
  - Objects

Passing Constant Example

```
// tablearg.cpp
// demonstrates function arguments
#include <iostream.h>

void repchar (char, int);
    //function declaration
int main( )
{
repchar('-' , 43);                    //call to
    function
cout << "Date type   Range" << endl;
repchar('=', 23);                     // call to
    function
cout << "char   -128 to 127" << endl
     << "short   -32, 768 to 32, 767" << endl
     << "int system dependent" << endl
    << "double  -2, 147, 483, 648 to 2, 147, 483,
    647" << endl;
repchar('-', 43);                     // call to
    function
return 0;
}
```

```
//.................................
// repchar()
// function definition
void repchar (char ch, int n)
{
for (int j=0; j<n; j++)
cout << ch;
cout << endl;
}
```

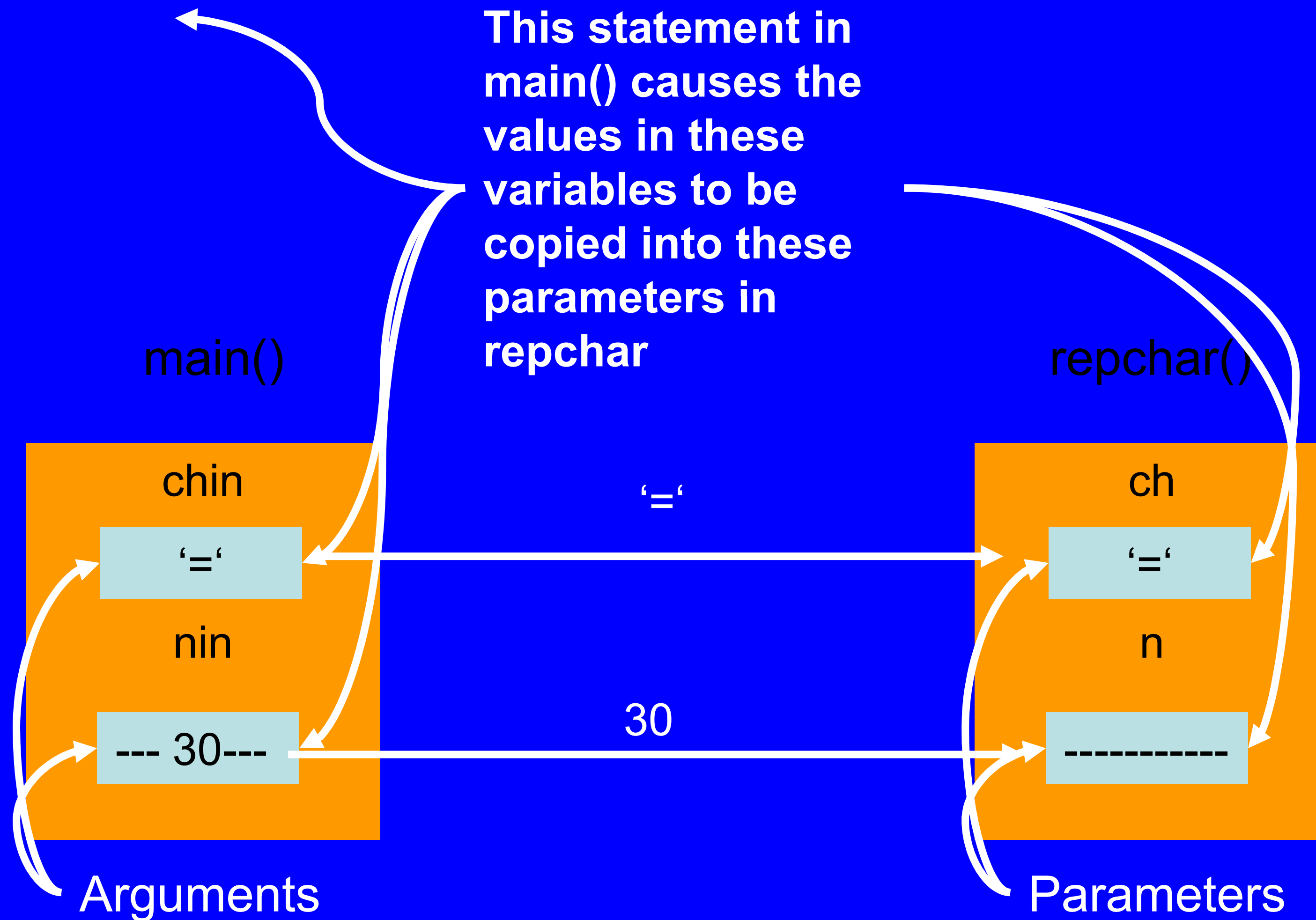
Passing Variable Example

```
// vararg.cpp
// demonstrates variable arguments
#include <iostream>
using namespace std;
void repchar(char, int);
int main()
{
char chin;
int nin;
cout << "Enter a character: ";
cin >> chin;
cout << "Enter number of times to
    repeat it: ";
cin >>nin;
repchar(chin, nin);
return 0;
}
```

```
//..................................
// repchar()
// function definition
void repchar (char ch, int n)
{
for(int j=0; j<n; j++) cout << ch;
cout << endl;
}
```

Variable Passed by Value

Repchar (chin,nin);



Example: Passing Variables

```
#include <iostream.h>

int ftoc (int);        //function declaration

int main()
{
    int ftemp;
    cout << "Enter temperature in degree Fahrenhite: ";
        cin >> ftemp;
        int ctemp = ftoc(ftemp);
        cout << "The temperature " <<ftemp<< " Degree Fahrenhite equals
    "
                <<ctemp<< " Degree Centigrade "<<endl;
return 0;
}
//..............................................
//function definition
    int ftoc (int temp)
    {
        return  (temp-32)*5/9;
    }
```

Example: Passing constant, Variable & Expression

```
#include <iostream.h>

int square(int);

int main()
{
    int x = 5, y= 7;
    cout << square(9) <<endl
         << square (x) << endl
         <<square (x+y) << endl
         << square (x+y+7) <<endl;

return 0;
}

int square(int a)

{
    return a *=a;
}
```

Returning Values from Function

- Return value consist of an answer to the problem the function has solved
- When a function returns a value, the data type of this value must be specified
- The function declaration does this by placing the data type e.g.

```
float lbstokg(float);
```

before the function name in the declaration and the definition

Returning Values from Function

```
// convert.cpp
// demonstrates return values, converts pounds to kg
#include <iostream.h>

float lbstokg(float);      //declaration

int main()
{
float lbs, kgs;
cout << "\nEnter your weight in pounds; ";
cin >> lbs;
kgs = lbstokg(lbs);
cout << "Your weight in kilograms is " << kgs << endl;
return 0;
}
```

Returning Values from Function

```
//...............................
// lbstokg()
// converts pounds to kilograms
float lbstokg(float pounds)
{
float kilograms = 0.453592 * pounds;
return kilograms;
}
```

The Return Statement

- The function lbstokg() is passed an argument representing a weight in pounds, which it stores in the parameter pounds.
- The result is stored in the variable kilogram
- The value then returned to the calling program using a return statement

```
return kilogram;
```

Return Statement

kgs = lbstokg(lbs);

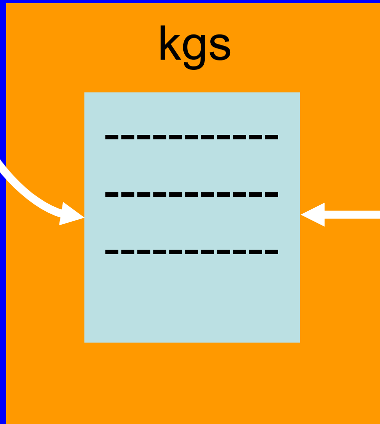
return kilograms;

2. This statement in main() causes the Return value to be assigned to this variable

1.This statement in lbstokg() causes the return value to be assigned to this variable

main()

repchar()



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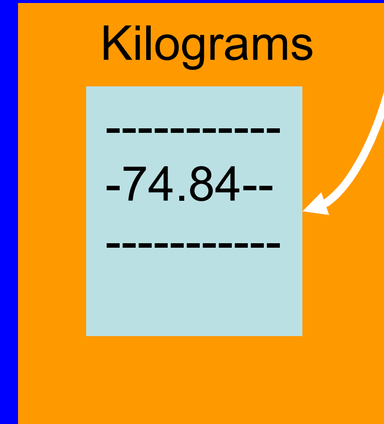


Reference Arguments

- A reference provides an alias – a different name – for a variable
- Passing arguments by value is useful when the function does not to modify the original variable in the calling program.
- It offers insurance that the function cannot harm the original variable
- Passing arguments by reference uses a different mechanism. Instead of a value being passed to the function , a reference to the original variable , in the calling program is passed

Reference Arguments

- An important advantage of passing by reference is that the function can access the actual variable in the calling program.
- Among other benefits, this provides a mechanism for passing more than one value from the function back to the calling program

Referencing: Creating Aliases

```
#include <iostream.h>

int main()
{
    int x = 3;
    int &y = x;
    cout<<"x= "<<x<<endl<<"y= "<<y<<endl;
    y=7;
    cout<<"x= "<<x<<endl<<"y= "<<y<<endl;
    x=33;
    cout<<"x= "<<x<<endl<<"y= "<<y<<endl;
return 0;
}
```

Referencing : Example

```
// comparing pass by value and pass by reference
#include <iostream>
using namespace std;

int squareByValue(int);
void squareByReference(int&);

int main()
{
    int x = 2, z = 4;
    cout << "x = "<<x<< " before squareByValue\n"
            <<"Value returned by squareByValue: "
            << squareByValue(x)<<endl
    <<"x= "<<x<< " after squareByValue\n"<<endl;


    cout <<"z = "<<z<< " before
    squreByReference"<< endl;
    squareByReference(z);
    cout << "z = " << z << " after
    squareByReference" << endl;

return 0;
}
```

```
int squareByValue(int a)

{
    return a *=a;
}

void squareByReference (int
    &y)
{
    y *=y;
}
```

```
x = 2 before squareByValue
Value returned by squareByValue: 4
x= 2 after squareByValue

z = 4 before squreByReference
z = 16 after squareByReference
```

Passing Simple Data types by Reference

```
// ref.cpp
// demonstrates passing by reference
#include <iostream>
using namespace std;
int main()
{
void intfrac(float, float&, float&);                //declaration
float number, intpart, fracpart;                    //float variables
do {
cout << "\nEnter a real number: ";                  //number from user
cin >> number;
intfrac(number, intpart, fracpart);                 //find int and frac
cout << "Integer part is " << intpart               //print them
      << " fraction part is  " << fracpart << endl;
}  while ( number != 0.0 );                         //exit loop on 0.0
return 0;
}
```

Passing Simple Data types by Reference

```
//.................................................
// intfrac()
// finds  integer and fractional parts of real number
void intfrac(float n, float& intp, float& fracp)
{
    long temp = static_cast<long> (n);  // convert to long,
    intp = static_cast<float> (temp);     //back to float
    fracp = n - intp;                              //subtract integer part
}
```

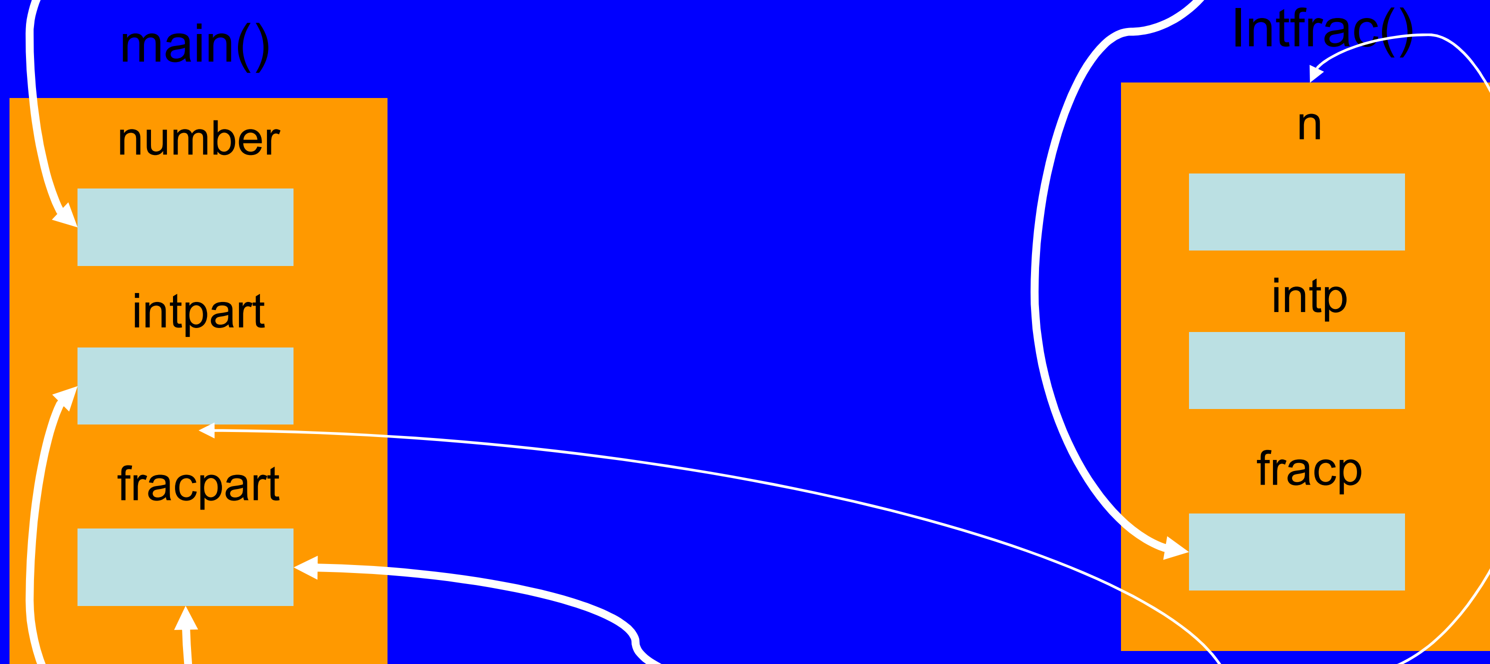
Passing Simple Data types by Reference

- The program will separate this number into an integer and a fractional part i.e the user number is 12.456 the program should report that the integer part is 12.0 and the fractional part is 0.456
- Library function fmod() performs the similar tasks for type double.

Passing Simple Data types by Reference

Intfrac(number,intpart,fracpart);

This statement in main() causes this variable to be copied into this parameter it also sets up aliases for these variables with these names




```
Fracp=n-intp;
Long temp = static_cast<long>(n);
```

These statements in intfrac() operate on these variable as if they were in intfrac()

A More Complex Pass by Reference

```
// reforder.cpp
// orders two arguments passed by reference
#include  <iostream>
using namespace std;
int main()
{
void order(int&, int&);                    //prototype
int n1=99, n2=11;                          //this pair not ordered
int n3=22, n4=88;                          //this pair ordered
order(n1, n2);                             //order each pair of numbers
order(n3, n4);
cout << "n1=" << n1 << endl;               //print out all numbers
cout << "n2=" << n2 << endl;
cout << "n3=" << n3 << endl;
cout << "n4=" << n4 << endl;
return 0;
}
```

A More Complex Pass by Reference

```
//……………………………….
void order(int& numb1, int& numb2)   //if 1st larger than 2nd,
{
if (numb1>numb2)
{
int temp = numb1;                    //swap them
numb1 = numb2;
numb2 = temp;
}
}
```

Function Overloading

- A C++ programmer may use the same name for more than one function.
- This would typically be done for different but related functions that perform similar tasks.
- *Function overloading* defines a new meaning for a function name that is already in use.

Function Overloading Contd..

- These two functions are different, even though they have the same name

```
int sqrt (int x)
 {
   ....
 }

 double sqrt (double x)
 {
   ....
 }
```

Function Overloading Contd..

- In C++, when the compiler sees a function call, it selects one from its list of known functions by examining both the called function name and the arguments provided in the call.
- When an overloaded function is called the compiler selects the proper function by examining the *number*, *types* and *order* of the arguments in the call.

Function Overloading Contd..

- Function Signature
  - **The combination of a function's name and its parameter list is called its *signature*. Every function must have a unique signature**
  - **Overloaded functions (functions with same name) can have different return types but must have different parameter list.**

Examples : Function Overloading

```
// some function prototypes
   void fun (void);
   int fun (int);                 // valid overloading
   double fun (int, int)          // valid overloading
   double fun (int);              // illegal redefinition
   int fun (void);                // illegal redefinition
```

Function Overloading Example

```
// overload.cpp
// demonstrates function overloading
#include <iostream>
using namespace std;

void repchar();                        //declarations
void repchar(char);
void repchar(char, int);

int main()
{
repchar();
repchar( '=' );
repchar( '+', 30);
return 0;
}
```

Function Overloading Example

```
//..................................
// repchar()
// displays 45 astericks
void repchar()
{
for(int j=0;  j<45;  j++)       //always loops 45 times
     cout << '*' ;              //always prints astericks
cout << endl;
}
//.................................
// repchar()
// displays 45 copies of specified character
void repchar (char ch)
{
for (int j=0;  j<45;  j++)      // always loops 45 times
     cout << ch;                // prints specified character
     cout << endl;
}
//..................................
// repchar()
// displays specified number of copies of specified character
void repchar(char ch, int n)
{

     for(int  j=0;  j<n;  j++)  // loops n times
     cout << ch;                //prints specified character
cout << endl;
}
```

RECURSION

- Existence of functions makes possible a programming technique called recursion
- Recursion involves a function calling itself
- Recursion is much easier to understand with an example than with lengthy explanations

RECURSION EXAMPLE

```
//factor2.cpp
//calculate factorials using recursion
#include<iostream>
using namespace std;
unsigned long factfunc(unsigned long);          //declaration
int main()
{
    int n;
unsigned long fact;                //factorial
cout<<"Enter an integer : ";
cin>>n;
fact=factfunc(n);
cout<<"Factorial of "   <<n <<" is " <<fact <<endl;
return 0;
}
```

RECURSION EXAMPLE

```
//.........................
//factfunc()
//calls itself to calculate factorial
unsigned long factfunc(unsigned long n)
{
if (n>1)
return n*factfunc(n-1);     //self call
else
return 1;
}
```

Inline Functions

- To save execution time in short functions
- At a function call in the source file the actual code is inserted, instead of jump to the function
- Inline library functions are usually defined (not just declared) in header files

INLINE FUNCTION EXAMPLE

```
//inline.cpp
//demonstrate inline function
#include<iostream>
using namespace std;
//lbstokg()
//converts pound to kilograms
inline float lbstokg(float pounds)
{
return 0.453592*pounds;
}
//.........................
int main()
{
float lbs;
cout<<"\nEnter your weight in pounds: ";
cin>>lbs;
cout<<"Your weight in kilogram is " <<lbstokg(lbs)<<endl;
return 0;
}
```

Default Argument

- A function can be called without specifying all its argument
- Default argument is useful if you don’t want to go to the trouble of writing arguments i.e. almost always have the same value
- Using default arguments means that the existing function calls can continue to use the old number of arguments while new functions calls can use more

Default Argument Example

```
//missarg.cpp
//demonstrate missing and default argument
#include<iostream>
using namespace std;
void repchar(char='*',int=45);
int main()
{
repchar();
repchar('=');
repchar('+',30);
return 0;
}
```

```
//..........................
//repcahr()
//display line of characters
void repchar(char ch, int n)
{
for (int j=0;j<n ; j++)
cout <<ch;
cout <<endl;
}
```

Variables and Storage Classes

- Storage Class of a variable
  - It determines which part of the program can access it and how long it stays in existence
- Three storage classes
  - Automatic or Local Variables
  - External or Global Variables
  - Static Local Variables

Automatic Variables or Local Variables

- Variables defined within a function body
- Sometime auto keyword is used
- Lifetime
  - Variable is not created until the function in which it is defined is called
  - When called function returns and control passed to the calling program, the variables are destroyed and their value is lost
- Visibility or Scope
  - Location within a program from which it can be accessed (With in a function)
- Initialization
  - When variable is created it is not initialized by compiler

External or Global Variables

- Variables defined outside a function body
- Lifetime
  - Exists for the life of the program
- Visibility or Scope
  - Visible to all the functions that follow the definition in a program
- Initialization
  - When variable is created it is automatically initialized to 0

Example : Global Variables

```
// extern.cpp
// demonstrates global variables
#include<iostream>
#include<conio.h>
using namespace std;
char ch = 'a';    //global variable
void getachar();
void putachar();
int main()
{
    while(ch != '\r')
    {
        getachar();
        putachar();
    }
    cout<<endl;
    return 0;
}
```

```
//.............
void getachar()
{
    ch=getch();
}
//.............
void putachar()
{
    cout<<ch;
}
```

Static Local Variables

- Lifetime
  - Created on first call of the function and exists for the life of the program
- Visibility or Scope
  - Visible within the function
- Initialization
  - Initialized only once per program

Example : Static Local Variable

```
// static.cpp
// Demonstrates static variables
#include<iostream>
using namespace std;
float getavg(float);

int main()
  {
  float data=1, avg;

  while( data != 0 )
    {
    cout << "Enter a number: ";
    cin >> data;
    avg = getavg(data);
    cout << "New average is "
    << avg << endl;
    }
  return 0;
  }
```

```
//------------------------------------------------------------
// getavg()
// finds average of old plus new data
float getavg(float newdata)
  {
  static float total = 0;  //static variables are initialized
  static int count = 0;    // only once per program
  count++;                 //increment count
  total += newdata;        //add new data to total
  return total / count;    //return the new average
  }
```

Variable Storage Classes Another Example

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

void a(void);          //function declarations
void b(void);
void c(void);
int x = 1;  //global variable
int main()
{
    int x = 5;          //local variable to main

    cout << "local x in outer scope of main is "<<x<<endl;
    {       // starting a new scope
            int x = 7;
            cout << "local x is in inner scope of main is "<<x<<endl;
    }       //end of inner or new scope
    cout << "local x in outer scope of main is "<<x<<endl;
    a();    //func a has automatic local x
    b();    //func b has static local x
    c();    //func c uses a global x
    a();    //func a reinitializes automatic local x
    b();    //static local x retains its previous value
    c();    //global x also retains its value
    cout << "local x in main is "<<x<<endl;
    return 0;
}
```

Contd’

Variable Storage Classes Another Example..Contd

```
void a(void)
{
    int x = 25;      //initialized each time a is called
    cout<<endl<<"local x in a is "<<x<<" after entering a"<<endl;
    ++x;
    cout<<"local x in a is "<<x<<" before exiting a"<<endl;
}
void b(void)
{
    static int x = 50;         //intialization only first time
                                                   //b is called
    cout<<endl<<"local staic x is "<<x<<" on entering b"<<endl;
    ++x;
    cout<<"local static x is "<<x<<" on exiting b"<<endl;
}
void c(void)
{
    cout<<endl<<"global x is "<<x<<" on entering c"<<endl;
    x *= 10;
    cout <<"global x is "<<x<<" on exiting c"<<endl;
}
```

THE END