# Εισαγωγή στις γλώσσες C και C++

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## Βασικά Στοιχεία Γλωσσών

- Οι γλώσσες προγραμματισμού αποτελούν εργαλεία για την ανάπτυξη πακέτων λογισμικού (προγράμματα).
- Πρόγραμμα = Υλοποίηση Αλγορίθμων + Υλοποίηση Δομών Δεδομένων

## Διαχωρισμός Γλωσσών

- Δομημένες Γλώσσες Προγραμματισμού, όπως Pascal, C
- Γλώσσες Βασισμένες στα Αντικείμενα (object-oriented), C++, Java.



## Ένα Απλό Παράδειγμα C

```
# include <stdio.h>
main ( )
{
        int x, y;
        x = 5;
        y=4;
        printf ("x + y = %d", x+y);
}
```

## Χαρακτηριστικά της C

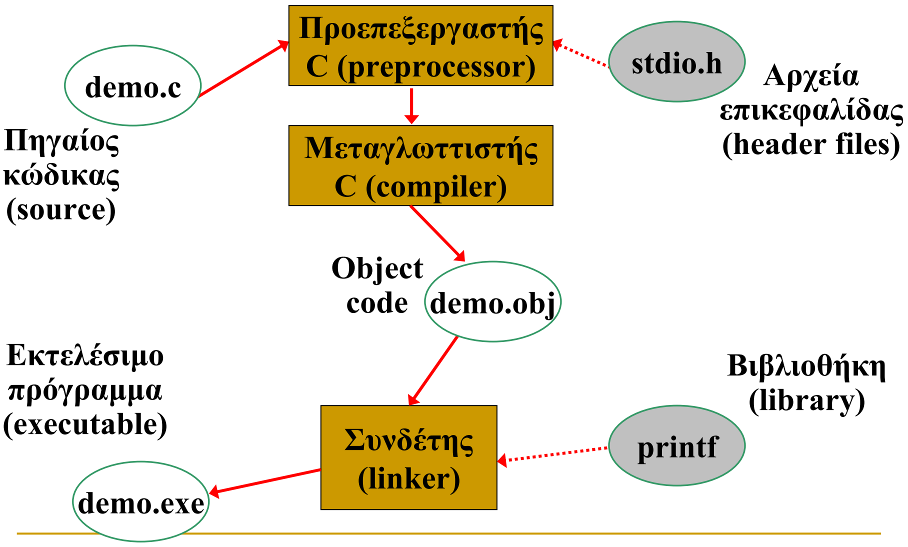
- Γλώσσα μετρίου επιπέδου
- Οικονομία στην έκφραση
  (λιτή και περιεκτική)
- Σχετικά χαλαρό σύστημα τύπων
- Φιλοσοφία: ο προγραμματιστής έχει πλήρη έλεγχο και ευθύνεται για τα σφάλματά του



## Χαρακτηριστικά της C

- Ιδιαίτερα δημοφιλής στην πράξη
- Έχει χρησιμοποιηθεί για τον προγραμματισμό ευρέως φάσματος συστημάτων και εφαρμογών
- Έχει χρησιμοποιηθεί ως βάση για πληθώρα άλλων γλωσσών: C++, Java

## Εκτέλεση Προγραμμάτων






## Πιο Σύνθετο Παράδειγμα C

```
#include <stdio.h>

void main ()
{
   int celcius;
   double farenheit;

   printf("Give the temperature (C): ");
   scanf("%d", &celcius);
   farenheit = 9.0 * celcius / 5.0 + 32.0;
   printf("%d degrees Celcius ”
          "is %lf degrees Farenheit",
          celcius, farenheit);
}
```

## Βασικοί Τύποι Δεδομένων

```
char, signed char, unsigned char
signed short int, unsigned short int
signed int , unsigned int
signed long int , unsigned long int
float, double, long double
```



## Μεταβλητές

```
int x;
int x, y, z;
double r;
unsigned long abc;

int x = 1;
int x, y = 0, z = 2;
double r = 1.87;
unsigned long abc = 42000000;
```

## Σταθερές

- ακέραιες σταθερές

| | | | |
|---|---|---|---|
| `42` | `0` | `-1` | δεκαδικές |
| `037` | | | οκταδικές |
| `0x1f` | | | δεκαεξαδικές |
| `42U` | `42L` | `42UL` | unsigned & long |

- σταθερές κινητής υποδιαστολής

| | | |
|---|---|---|
| `42.0` | `-1.3` | δεκαδικές |
| `2.99e8` | | με δύναμη του 10 |
| `42.0F` | `42.0L` | float & long double |



## Σταθερές (συνέχεια)

- χαρακτήρα

  `'a'` `'0'` `'$'`

- ειδικοί χαρακτήρες

| | |
|---|---|
| `\n` | αλλαγή γραμμής |
| `\'` | απόστροφος |
| `\\` | χαρακτήρας \ (backslash) |
| `\t` | αλλαγή στήλης (tab) |
| `\"` | εισαγωγικό |
| `\0` | χαρακτήρας με ASCII = 0 (null) |
| `\037` | » με ASCII = 37 (οκταδικό) |
| `\x1f` | » με ASCII = 1f (δεκαεξαδικό) |

## Σταθερές (συνέχεια)

- συμβολοσειρές

```
"abc"    "Hello world!\n"   "a\"51\""
```

- δηλώσεις σταθερών

```
const int size = 10, num = 5;
const double pi = 3.14159;
const char newline = '\n';
```



## printf ( ): εκτύπωση

- απλοί τύποι δεδομένων
  - int **%d**
  - char **%c**
  - double **%lf**
  - string **%s**
- παράδειγμα

```
printf("%d %lf %c %s\n",
   42, 1.2, 'a', “aloha");
```

- αποτέλεσμα

```
42 1.200000 a aloha
```

## scanf ( ): ανάγνωση

- Ίδιοι κωδικοί για τους απλούς τύπους
- Παράδειγμα

```
int n;
double d;
char c;
scanf("%d", &n);
scanf("%lf", &d);
scanf("%c", &c);
```



## Τελεστές και Εκφράσεις

- αριθμητικοί τελεστές
  `+ -  *  /  %`
- σχεσιακοί τελεστές
  `==  !=  <  >  <=  >=`
- λογικοί τελεστές
  `&&` λογική σύζευξη (και)
  `||` λογική διάζευξη (ή)
  `!` λογική άρνηση (όχι)
- π.χ. `(x % 3 != 0) && !finished`

## Τελεστές και Εκφράσεις (συνέχεια)

- τελεστές bit προς bit (bitwise)
  - & σύζευξη bit (AND)
  - | διάζευξη bit (OR)
  - ^ αποκλειστική διάζευξη bit (XOR)
  - ~ άρνηση (NOT)
  - << ολίσθηση bit αριστερά
  - >> ολίσθηση bit δεξιά
- παράδειγμα

```
(0x0101 & 0xfff0) << 2
```

⇒ `0x0400`



## Τελεστές και Εκφράσεις (συνέχεια)

- τελεστής συνθήκης
  `(a >= b) ? a : b`
- τελεστής παράθεσης
  `a-1, b+5`
- τελεστές ανάθεσης
  `a = b+1`
  `a += x` ισοδύναμο με `a = a + x`
- τελεστές αύξησης και μείωσης
  `a++ a--` τιμή πριν τη μεταβολή
  `++a --a` τιμή μετά τη μεταβολή

## Έλεγχος Ροής Προγράμματος

- Εντολή if

```
if (a >= b)
  max = a;
else
  max = b;
```



## Έλεγχος Ροής Προγράμματος

- Σύνθετη εντολή

```
if (a >= b) {
  min = b;
  max = a;
}
else {
  max = b;
  min = a;
}
```

- Ορίζει νέα εμβέλεια

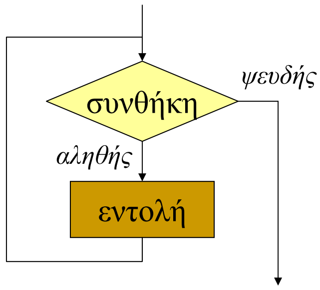
```
if (x < y) {
  int temp = x;

  x = y;
  y = temp;
}
```

# Έλεγχος Ροής Προγράμματος

```
while (συνθήκη)
   εντολή
```

- Εντολή while

```
int i = 1, s = 0;
while (i <= 10) {
   s += i;
   i++;
}
```



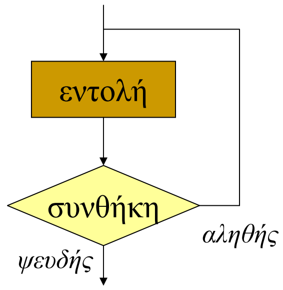



# Έλεγχος Ροής Προγράμματος

```
do
  εντολή
while (συνθήκη);
```

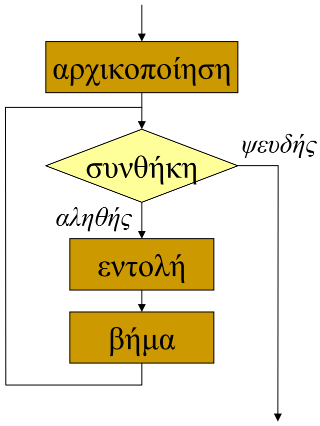
- Εντολή do-while

```
int i = 1, s = 0;
do
{
   s += i++;
} while (i <= 10);
```



## Έλεγχος Ροής Προγράμματος

```
for (αρχικοποίηση ;
     συνθήκη ;
     βήμα)
  εντολή
```




- Εντολή for

```
int i, s;
for (i=1, s=0; i <= 10; i++)
  s += i;
```



## Εντολή break

```
int s;
for (i=0, s=0; i < 10; i++) {
    int x;
    scanf("%d", &x);
    if (x < 0)
        break;
    s += x;
}
printf("Sum is: %d\n", s);
```

## Εντολή continue

```
int s;
for (i=0, s=0; i < 10; i++) {
    int x;
    scanf("%d", &x);
    if (x < 0)
        continue;
    s += x;
}
printf("Sum is: %d\n", s);
```



## Εντολή switch

```
switch (ch) {
     case 'a':
        printf("alpha\n");
        break;
     case 'b':
     case 'c':
        printf("beta or c\n");
        break;
     default:
        printf("other\n");
  }
```

## Εντολή goto

```
int i = 1, s = 0;

loop:
   s += i++;
   if (i < 10)
      goto loop;

printf("The sum is %d\n", s);
```

- Όχι goto: δομημένος προγραμματισμός!



## Αντικειμενοστρεφής Προγραμματισμός

**Τι είναι:**

Μοντέλο προγραμματισμού -> Ένας τρόπος σκέψης

**Τυπικός ορισμός:**

Η αντικειμενοστρέφεια (object-orientation) είναι μία προσέγγιση στην ανάπτυξη λογισμικού που οργανώνει τόσο το πρόβλημα όσο και τη λύση του ως μία συλλογή από διακριτά αντικείμενα.

**Τα αντικείμενα αλληλεπιδρούν για την επίλυση του προβλήματος**

## Αντικειμενοστρεφής Προγραμματισμός

**1967: Simula67 (Νορβηγία) -> πρώτη αντικειμενοστρεφής γλώσσα**

**’70: Smalltalk (Palo Alto, CA) -> κάθε στοιχείο ένα αντικείμενο**

**Αρχές ’80: ο αντικειμενοστρεφής τρόπος σκέψης εισάγεται σε ακαδημαϊκούς κύκλους**

**’80: C++ (Stroustrup, AT&T): σοβαρή, αποδοτική γλώσσα, πρότυπο στη βιομηχανία**

**1995**: JAVA, Sun Microsystems



## C++ Review

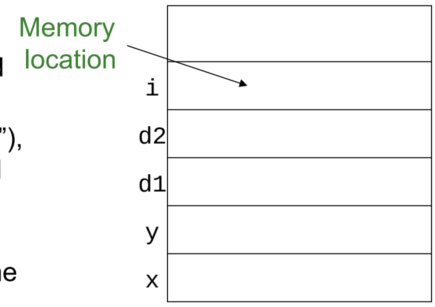
# Outline

- C++ basic features
  - Programming paradigm and statement syntax
- Class definitions
  - Data members, methods, constructor, destructor
  - Pointers, arrays, and strings
  - Parameter passing in functions
  - Templates
  - Friend
  - Operator overloading
- I/O streams
  - An example on file copy
- Makefile



# Functions & Memory

- Every function needs a place to store its local variables. Collectively, this storage is called the *stack*
- This storage (memory aka "RAM"), is a series of storage spaces and their numerical addresses
- Instead of using raw addresses, we use variables to attach a name to an address
- All of the data/variables for a particular function call are located in a *stack frame*

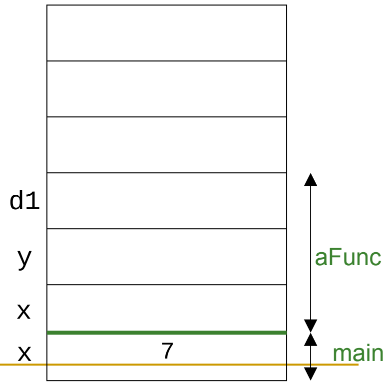



```
void aFunc(int x, int y)
{
  double d1, d2;
  int i;
}
```

## Functions & Memory (cont)

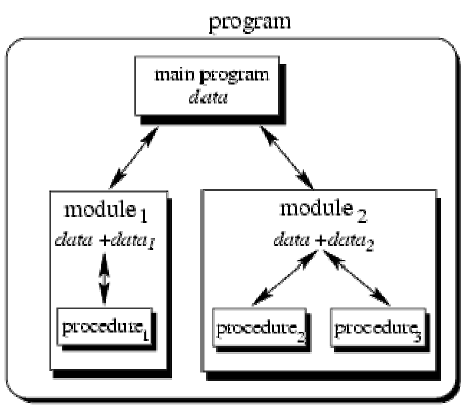
- When a function is called, a new stack frame is set aside
- Parameters and return values are passed *by copy* (ie, they're copied into and out of the stack frame)
- When a function finishes, its stack frame is reclaimed

```
void aFunc(int x, int y) {
  double d1 = x + y;
}
int main(int argc,
         const char * argv[]) {
   int x = 7;
   aFunc(1, 2);
   aFunc(2, 3);
   return 0;
}
```






## Programming Paradigm: Modular Concept



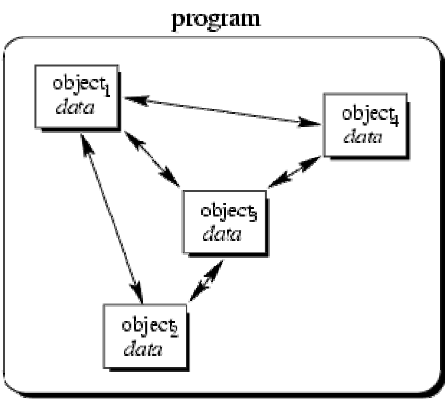

- The main program coordinates calls to procedures in separate modules and hands over appropriate data as parameters

# Modular Concept - Problems

- **Decoupled Data and Operations**
  - The resulting module structure is oriented on the operations rather than the actual data
  - The defined operations specify the data to be used.



# Object-Oriented Concept (C++)




- Objects of the program interact by sending messages to each other

## Basic C++

- Inherit all C syntax
  - Primitive data types
    - Supported data types: `int, long, short, float, double, char, bool, and enum`
    - The size of data types is platform-dependent
  - Basic expression syntax
    - Defining the usual arithmetic and logical operations such as `+, -, /, %, *, &&, !`, and ||
    - Defining bit-wise operations, such as `&, |`, and ~
  - Basic statement syntax
    - `If-else, for, while,` and `do-while`



## Basic C++ (cont)

- Add a new comment mark
  - // For 1 line comment
  - /*… */ for a group of line comment
- New data type
  - Reference data type “&”. Much likes pointer

```
int ix; /* ix is "real" variable */
int & rx = ix; /* rx is "alias" for ix */
ix = 1; /* also rx == 1 */
rx = 2; /* also ix == 2 */
```

- *const* support for constant declaration, just likes C

# Class Definitions

- A C++ class consists of *data members* and *methods (member functions).*

```
class IntCell
{
   public:
      explicit IntCell( int initialValue = 0 )
         :  storedValue( initialValue ) {}

      int read( ) const
         { return storedValue;}
      void write( int x )
         { storedValue = x; }
   private:
      int storedValue;
}
```

Avoid implicit type conversion

Initializer list: used to initialize the data members directly.

Member functions

Indicates that the member's invocation does not change any of the data members.

Data member(s)



# Information Hiding in C++

- Two labels: *public* and *private*
  - Determine visibility of class members
  - A member that is *public* may be accessed by any method in any class
  - A member that is *private* may only be accessed by methods in its class
- Information hiding
  - Data members are declared *private,* thus restricting access to internal details of the class
  - Methods intended for general use are made *public*

## Constructors

- A *constructor* is a special method that describes how an instance of the class (called *object*) is constructed
- Whenever an instance of the class is created, its constructor is called.
- C++ provides a *default constructor* for each class, which is a constructor with no parameters. But, one can define multiple constructors for the same class, and may even redefine the default constructor

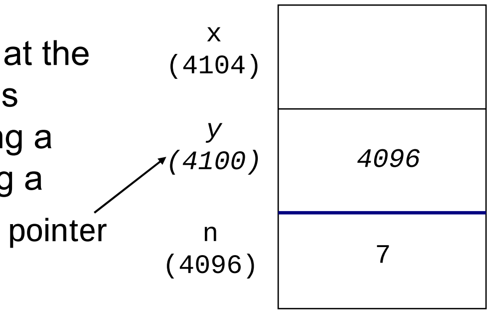


## Destructor

- A *destructor* is called when an object is deleted either implicitly, or explicitly (using the *delete* operation)
  - The destructor is called whenever an object goes out of scope or is subjected to a *delete.*
  - Typically, the destructor is used to free up any resources that were allocated during the use of the object
- C++ provides a *default destructor* for each class
  - The default simply applies the destructor on each data member. But we can redefine the destructor of a class. A C++ class can have only one destructor.
  - One can redefine the destructor of a class.
- A C++ class can have only one destructor

# Pointers

- A *pointer* is a variable which contains addresses of other variables
- Accessing the data at the contained address is called "dereferencing a pointer" or "following a pointer"



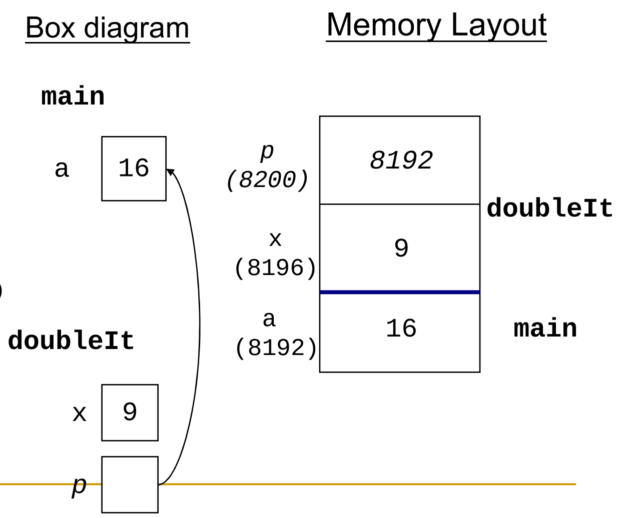



# A Pointer Example

The code

```
void doubleIt(int x,
              int * p)
{
   *p = 2 * x;
}
int main(int argc,
   const char * argv[])
{
   int a = 16;
   doubleIt(9, &a);
   return 0;
}
```

a gets 18



# Interface and Implementation

- In C++ it is more common to separate the *class interface* from its *implementation*.
- The *interface* lists the class and its members (data and functions).
- The *implementation* provides implementations of the functions.



```
class IntCell
{
    public:
        explicit IntCell( int initialValue = 0 );
        int read( ) const;
        void write( int x );
    private:
        int storedValue;
}
```

*IntCell.h*

```
IntCell::IntCell( int initialValue )
     : storedValue ( initialValue ) { }

int IntCell::read( ) const
     { return storedValue; }

void IntCell::write( )
      { storedValue = x; }
```

*IntCell.cpp*

The interface is typically placed in a file that ends with *.h*. The member functions are defined as:

*ReturnType* FunctionName(*parameterList*);

The implementation file typically ends with *.cpp*, *.cc*, or *.C*. The member functions are defined as follows:

*ReturnType* ClassName::FunctionName(*parameterList)*
{ …… }

*Scoping operator*

## Object Pointer Declaration

- Declaration

  ```
  IntCell * p; //defines a pointer to an object of
     class IntCell
  ```

  - The * indicates that *p* is a pointer variable; it is allowed to point at an IntCell object.
  - The *value* of *p* is the address of the object that it points at
  - *P* is uninitialized at this point
  - The use of uninitialized pointers typically crashes programs

Δομές Δεδομένων 47

## Dereferencing Pointers

- Dynamic object creation

  *p = new* IntCell;


  In C++ *new* returns a pointer to the newly created object.
- Garbage collection
  - C++ does not have garbage collection
  - When an object that **is allocated by *new*** is no longer referenced, the *delete* operation must be applied to the object

    delete *p;*

Δομές Δεδομένων 48

# Dereferencing Pointers (cont)

- Using a pointer

  We can get the value of the object pointed at by a pointer either by using operator *, or by using operator ->

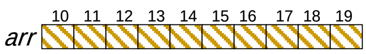
```
IntCell a;
int b;
……
a = *p; //variable a gets the value of object pointed at by p
b = p->read( ); //the value of the data member storedValue of
                             // the object pointed at by p is assigned
   to b
```



# Array Declaration

- An *array* is a collection of objects with same type stored consecutively in memory
- Declaring an array

  `IntCell arr[10]; //an array consisting of 10 IntCell objects`




  - The size of the array must be known at compile time.
  - *arr* actually is a constant pointer. The value of *arr* **cannot** be changed.

```
IntCell * p = new IntCell[10];
arr = p; // invalid
```

  - The *(i+1)*-st object in the array *arr* can be accessed either by using *arr[i]*, or by **(arr+i)*.
- There is no index range checking for arrays in C++
- Cannot be copied with =
- Arrays are *not* passed by copy. Instead, the address of the first element is passed to the function

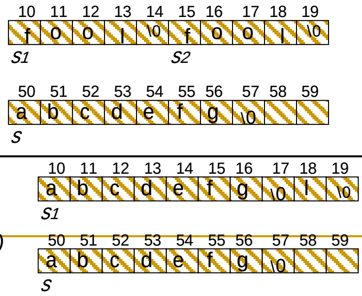
```
int sumOfArray( int values[], int numValues )
```

# Strings

- Built-in C-style strings are implemented as an array of characters.
- Each string ends with the special null-terminator '\0'.
- *strcpy*: used to copy strings
  *strcmp*: used to compare strings
  *strlen:* used to determine the length of strings
- Individual characters can be accessed by the array indexing operator

```
char s1[] = "fool";
char s2[] = "fool;
char s[]="abcdefg";
```

```
strcpy(s1, s);
//copy s to s1
//(s1 must have enough size)
//including \0
```






# Function Call by Value

```
int f(int x) { cout << "value of x = " << x << endl;
                  x = 4; }
main() { int v = 5;
             f(v);
             cout << "value of v = " << v << endl;}
```

*Output:* Value of x = 5
Value of v = 5

- When a variable *v* is passed *by value* to a function *f*, its value is copied to the corresponding variable *x* in *f*
- Any changes to the value of *x* does NOT affect the value of *v*
- Call by value is the default mechanism for parameter passing in C++

## Function Call by Reference

```
int f(int &x) { cout << "value of x = " << x << endl;
                  x = 4; }
main() { int v = 5;
             f(v);
             cout << "value of v = " << v << endl;}
```

*Output:* Value of x = 5

Value of v = 4

- When a variable *v* is passed *by reference* to a parameter *x* of function *f*, *v* and the corresponding parameter *x* refer to the same variable
- Any changes to the value of *x* DOES affect the value of *v*



## Function Call by Constant Reference

```
int f( const int &x ) { cout << "value of x = " << x <<
  endl;
                  x = 4;  // invalid
                  }
main() { int v = 5;
             f(v);
             cout << "value of v = " << v << endl;
         }
```

- Passing variable *v by constant reference* to parameter *x* of *f* will **NOT** allow any change to the value of *x.*
- It is appropriate for passing large objects that should not be changed by the called function.

## Usage of Parameter Passing

- *Call by value* is appropriate for small objects that should not be changed by the function
- *Call by constant reference* is appropriate for large objects that should not be changed by the function
- *Call by reference* is appropriate for all objects that may be changed by the function



## Reference Variables

- Reference and constant reference variables are commonly used for parameter passing to a function
- They can also be used as local variables or as class data members
- A reference (or constant reference) variable serves as an alternative name for an object.

```
int m = 10;
int & j = m;
cout <<"value of m = " << m << endl; //value of m
   printed is 10
j = 18;
cout << "value of m = " << m << endl; //value of m
   printed is 18
```

# Reference Variables (cont)

- A reference variable is different from a pointer
  - A pointer need NOT be initialized while defining, but a reference variable should always refer to some other object.

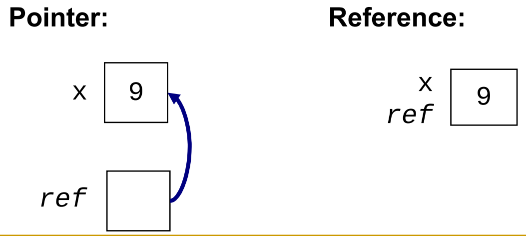
```
int * p;
int m = 10;
int & j = m; //valid
int & k; //compilation error
```



# References (Summary)

*References are an additional name to an existing memory location*

If we wanted something called "`ref`" to refer to a variable `x`:



## Pointer vs. Reference

- A pointer can be assigned a new value to point at a different object, but a reference variable always refers to the same object. Assigning a reference variable with a new value actually changes the value of the referred object.

```
int * p;
int m = 10;
int & j = m; //valid
p = &m; //p now points at m
int n = 12;
j = n; // the value of m is set to 12. But j still refers to m,
   not to n.
cout << "value of m = " << m <<endl; //value of m printed is 12
n = 36;
Cout << "value of j = " << j << endl; //value of j printed is
   12
p = &n;
```



## Pointer vs. Reference (cont)

- A *constant reference variable* *v* refers to an object whose value cannot be changed through *v.*

```
int m = 8;
const int & j = m;
m = 16; //valid
j = 20; //compilation error
```

## C++ - Template

- **Template is a generic types**

```
template <class T, int size>
  class Stack {
    T _store[size];

  public:
    ...
  };
  Stack<int,128> mystack;
```

- The *template* in C++ is a way to achieve type-independent algorithms



## Template Details

- Function templates
  - A *function template* is not an actual function, but instead is a pattern for what could become a function.

```
template <class Comparable>
const Comparable & findMax( const
          vector<Comparable> & a )
{
    int maxIndex = 0;
    for (int j=1; j < a.size( ); j++ )
        if ( a[maxIndex] < a[j])
          maxIndex = j;
    return a[maxIndex];
}
```

```
int main( )
{
    vector<int>       v1(37);
    vector<string>   v2(60);
    vector<IntCell>  v3(75);
     …………………….
    cout<<findMax(v1)<<endl;//OK:Comparable=int
    cout<<findMax(v2)<<endl;//OK:Comparable=string
    cout<<findMax(v3)<<endl;//Illegal;
                            //operator< undefined
}
```

  - The template argument can be replaced by any type to generate a function.
  - Since the function returns a reference, const Comparable & is to make sure that the array element returned would not be changed by the call such as findMax(a) = 10
  - When deciding on parameter-passing and return-passing conventions, it should be assumed that template arguments are not primitive types.

## Return by reference

```
int & foo(int &b){
  return b;
}

main(){
  int j;
  int a = 5;

  j=foo(a);  //j is 5
  j=3;  // a is still 5

  foo(a) = 10; //a is now 10
}
```

```
const int & foo(int &b){
  return b;
}

main(){
  int j;
  int a = 5;

  j=foo(a);  //j is 5
  j=3;  // a is still 5

  foo(a)= 10;  // invalid
}
```



## C++ Advanced Features

- C++ allow function overloading

```
#include <stdio.h>

  int max(int a, int b) {
    if (a > b) return a;
    return b;
  }

  char *max(char *a, char * b) {
    if (strcmp(a, b) > 0) return a;
    return b;
  }

  int main() {
    printf("max(19, 69) = %d\n", max(19, 69));
// cout << “max(19, 69) = “ << max(19, 69) << endl;
    printf("max(abc, def) = %s\n", max("abc", "def"));
// cout << “max(“abc”, “def”) = “ << max(“abc”, “def”) << endl;
    return 0;
  }
```

## A C++ Example

- point.h

```
class Point {
 private:
    int _x, _y;       // point coordinates

  public:             // begin interface section
    void setX(const int val);
    void setY(const int val);
    int getX() { return _x; }
    int getY() { return _y; }
  };

  Point apoint;
```



## Class and Objects

- point.cc, point.cpp

```
void Point::setX(const int val) {
    _x = val;
  }

  void Point::setY(const int val) {
    _y = val;
  }
```

# Main program

- main.cc, main.cpp

```
int main(int argc, char* argv[]) {
   Point apoint;

  apoint.setX(1);     // Initialization
  apoint.setY(1);

  //
  // x is needed from here, hence, we define it here
   and
  // initialize it to the x-coordinate of apoint
  //

  int x = apoint.getX();
}
```



# Constructor and Destructor

```
class Point {
 private :
   int _x, _y;
  public:
    Point() {
      _x = _y = 0;
    }
    Point(const int x, const int y);
    Point(const Point &from);
    ~Point() {void}

    void setX(const int val);
    void setY(const int val);
    int getX() { return _x; }
    int getY() { return _y; }
  };
```

## Constructor and Destructor

```
Point::Point(const int x, const int y)  : _x(x), _y(y) {
}

Point::Point(const Point &from) {
      _x = from._x;
      _y = from._y;
}

Point::~Point(void) {
   /* nothing to do */
}
```



## C++ Operator Overloading

```
class Complex {
    ...
  public:
    ...
    Complex operator +(const Complex &op) {
      double real = _real + op._real,
             imag = _imag + op._imag;
      return(Complex(real, imag));
    }
    ...
  };
```

In this case, we have made operator + a member of class Complex. An expression of the form

```
c = a + b;
```

is translated into a method call

```
c = a.operator +(a, b);
```

## Operator Overloading

- The overloaded operator may not be a member of a class: It can rather defined outside the class as a normal overloaded function.

  For example, we could define operator + in this way:

```
class Complex {
    ...
  public:
    ...
    double real() { return _real; }
    double imag() { return _imag; }

    // No need to define operator here!
  };
  Complex operator +(Complex &op1, Complex &op2) {
    double real = op1.real() + op2.real(),
           imag = op1.imag() + op2.imag();
    return(Complex(real, imag));
  }
```



## Friend

- We can define functions or classes to be friends of a class to allow them direct access to its private data members

```
class Complex {
    ...
    public:
    ...
    friend Complex operator +(
      const Complex &,
      const Complex &
    );
  };
  Complex operator +(const Complex &op1, const Complex &op2) {
    double real = op1._real + op2._real,
           imag = op1._imag + op2._imag;
    return(Complex(real, imag));
  }
```

## Standard Input/Output Streams

- Stream is a sequence of characters
- Working with cin and cout
- Streams convert internal representations to character streams
- >> input operator (extractor)
- << output operator (inserter)



## Reading Data >>

- Leading white space skipped
- Newline character <nwln> also skipped
- Until first character is located

  `cin >> ch;`
- Also read character plus white space as a character
  - `get` and `put` functions

## CountChars.cpp

### *Program Output*

```
Enter a line or press CTRL-Z: This is the first
  line.
This is the first line.
Number of characters in line 1 is 23
Enter a line or press CTRL-Z: This is the second
  line.
This is the second line.
Number of characters in line 2 is 24
Enter a line or press CTRL-Z: <---- <CTRL-Z>
Number of lines processed is 2
Total number of characters is 47
```



## CountChars.cpp (Header)

```
// File: CountChars.cpp
// Counts the number of characters and lines in
// a file

#include <iostream>
#include <string>

using namespace std;

#define ENDFILE "CTRL-Z"     //ENDFILE is a string
```

# CountChars.cpp (Setup)

```
int main()
{
   const char NWLN = '\n'; // newline character

   char next;
   int charCount;
   int totalChars;
   int lineCount;

   lineCount = 0;
   totalChars = 0;

   cout << "Enter a line or press "
        << ENDFILE << ": ";
```



# CountChars.cpp (Main Loop)

```
  while (cin.get(next)) {   // a new line, if user hits
  ^Z,
                            // cin.get returns 0
      charCount = 0;
      while (next != NWLN  &&  !cin.eof()){
         cout.put(next);
         charCount++;
         totalChars++;
         cin.get(next);
      }  // end inner while to get a line
      cout.put(NWLN);
      lineCount++;
      cout << "Number of characters in line "
           << lineCount << " is " << charCount << endl;
      cout << "Enter a line or press " << ENDFILE << ":
  ";
  }  // end outer while
```

## CountChars.cpp (Output)

```
    cout << endl << endl
         << "Number of lines processed is "
         << lineCount << endl;
    cout << "Total number of characters is "
         << totalChars << endl;
   return 0;
}
```



## File I/O

- Declare the stream to be processed:

```
#include <fstream>
ifstream ins; // input stream
ofstream outs;// output stream
```

- Need to open the files

```
ins.open(inFile);
outs.open(outFile);
```

## Files

- #define associates the name of the stream with the actual file name
- fail() function - returns nonzero if file fails to open
- Program CopyFile.cpp demonstrates the use of the other fstream functions
  - get, put, close and eof
  - Copy from one file to another



## CopyFile.cpp

*Program Output*

```
Input file copied to output file.
37 lines copied.
```

## CopyFile.cpp (Header)

```
// File: CopyFile.cpp
// Copies file InData.txt to file OutData.txt

#include <cstdlib>
#include <fstream>

using namespace std;

// Associate stream objects with external file
// names
#define inFile "InData.txt"
#define outFile "OutData.txt"
```



## CopyFile.cpp (Declarations)

```
// Functions used ...
// Copies one line of text
int copyLine(ifstream&, ofstream&);

int main()
{

    // Local data ...
    int lineCount;
    ifstream ins;
    ofstream outs;
```

## CopyFile.cpp (Opening Input File)

```
// Open input and output file, exit on any
// error.
ins.open(inFile);
if (ins.fail ())
{
   cerr << "*** ERROR: Cannot open " <<
        inFile << " for input." << endl;
   return EXIT_FAILURE;   // failure return
}  // end if
```



## CopyFile.cpp (Opening Output File)

```
outs.open(outFile);
if (outs.fail()) {
    cerr << "*** ERROR: Cannot open " << outFile
         << " for output." << endl;
    return EXIT_FAILURE;       // failure return
}  // end if
```

## CopyFile.cpp (Copy Line by Line)

```
   // Copy each character from inData to outData.
   lineCount = 0;
   do{
      if (copyLine(ins, outs) != 0)
         lineCount++;
   } while (!ins.eof());
   // Display a message on the screen.
   cout << "Input file copied to output file."
        << endl;
   cout << lineCount << " lines copied." << endl;
   ins.close();
   outs.close();
   return 0;       // successful return
}
```



## CopyFile.cpp (copyLine procedure)

```
// Copy one line of text from one file to
   another
// Pre: ins is opened for input and outs for
// output.
// Post:    Next line of ins is written to outs.
//          The last character processed from
//          ins is <nwln>;
//          the last character written to outs
//          is <nwln>.
// Returns: The number of characters copied.
```

## CopyFile.cpp (Character Reading)

```
int copyLine (ifstream& ins, ofstream& outs){
  // Local data ...
  const char NWLN = '\n';
  char nextCh;
  int charCount = 0;

  // Copy all data characters from stream ins to
  //     stream outs.
  ins.get(nextCh);
  while ((nextCh != NWLN) && !ins.eof()){
     outs.put(nextCh);
     charCount++;
     ins.get (nextCh);
  }  // end while
```



## CopyFile.cpp (Detection of EOF)

```
  // If last character read was NWLN write it
  // to outs.
  if (!ins.eof())
  {
     outs.put(NWLN);
     charCount++;
  }
  return charCount;
}  // end copyLine
```