Basic and Library Types

For : COP 3330.
Object oriented Programming (Using C++)
http://www.compgeom.com/~piyush/teach/3330

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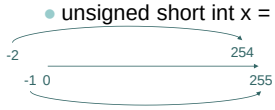
Basic C++ Types

- integer data-types :
  char, short, int, long, unsigned char, unsigned short,…
- floating point data-types :
  float, double, long double
- logical data-type : bool
  - bool constants : true, false
- character data-type : char and wchar_t
  - Char constants in single quotes : 'a'
- text data-type :
  string
  string constants in double quotes : "Hello world"

Basic C++ Types

Recommended assignments: 2.4/2.7/2.8/2.9

- void
  - Return type for a function with no return value
  - void pointers
- unsigned and signed integers
  - unsigned char x = -1; ?
  - unsigned short int x = -1; ?



Wrap around effect.
Machine dependent.

Basic Arithmetic types

Type	Low	High	Digits of Precision	Bytes
char	-128	127	-	1
short	-32768	32767	-	2
int	-2147483648	2147483647	-	4
long	-2147483648	2147483647	-	4
float	3.4×10^{-38}	3.4×10^{38}	7	4
double	1.7×10^{-308}	1.7×10^{308}	15	8
long double	3.4×10^{-4932}	3.4×10^{4932}	19	10

Variable Naming

- Read about hungarian naming:
- http://en.wikipedia.org/wiki/Hungarian_notation
- http://www.idleloop.com/hungarian/hungarian.html
- http://www.totse.com/en/technology/computer_technology/hungnote.html
- Use them in your next assignment onwards.

Hungarian naming

- Three parts
  - Base Type
  - One or more prefixes
  - Qualifier

Hungarian Base Types

- Specifies the type of the variable being named
- Not for predefined types
- Example:
  - wn = Window
  - scr = Screen
  - fon = Font
  - pa = Paragraph
- Example:
  - WN wnMain=NULL;
  - FONT fonUserSelected = TIMES_NEW_ROMAN;

Prefixes

- Go in front of the base type
- Somewhat standard list:
  - a = Array
  - c = Count
  - d = Difference
  - e = Element of an array
  - g = Global variable
  - h = Handle
  - i = index to array
  - m = Module-level variable
  - p(np, lp) = Pointer (near or long)
- Describes how the variable will be used.
- Examples
  - Array of windows: awnDialogs
  - Handle to a window: hwnMyWindow
  - Number of fonts: cfon

Qualifiers

- The rest of the variable name in case you were not using Hungarian naming.

More Examples

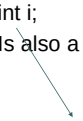
- bBusy : boolean
- cApples : count of items
- dwLightYears : double word
- fBusy : boolean (flag)
- iSize : integer
- fpPrice: floating-point
- dbPi: double
- pFoo : pointer
- rgStudents : array, or range
- szLastName : zero-terminated string
- u32Identifier : unsigned 32-bit integer
- m_nWheels : member of a class, integer

Variables

- What you should know?
  - Machine level representation of built in types.
  - Difference between : ‘a’ and “a”
  - Type of every entity in our program should be known to the compiler.

Variables

- Declaration
  - extern int i;
- Definition
  - int i;
  - Is also a declaration



Type specifier

Variable Initialization

Recommended Exercises: 2.15/2.16

- Direct initialization
  - float funity (1.0); → Can be more efficient for general classes.
  - std::string all_nines(10,'9'); // #include <string>
  - Happens when a variable is created and gives the variable its initial value.
- Copy initialization
  - float funity = 1.0;
  - Assignment involves replacing the current value of the variable with a new one.

More on this when we do "class" in detail.

Coding Standards

- Always initialize your variables
- Define variables where they are used.
- Pick names carefully.
- Be careful about scopes of variables
  - Global Scope
  - Local Scope
  - Statement scope

Const Qualifier

- for (int Index = 0; Index < 512; ++Index)
- const int ibufSize = 512;
- ibufSize = 0; // error: attempt to write to const object
- const int I , j = 0; ← What is wrong?
- Const objects are local to a file by default.
- Prefer const to #define
  - Using const instead of #define allows much better type checking and reduces name space pollution.

Const qualifier

- Const member functions
  - Specify which member functions can be invoked on const objects.

```
Class Rational { …
public:
        …
        const int numerator(void);
        …
        const Rational operator+(const Rational& rhs) const;
}

const Rational operator+(const Rational& lhs,
                         const Rational& rhs);
```

Const qualifier

- Const member functions
  - Specify which member functions can be invoked on const objects.

```
Class Rational { …
public:
        …
        const int numerator(void);
        …
        const Rational operator+(const Rational& rhs) const;
}

Rational a,b,c; a = b+c;
But does not allow (a+b) = c;
```

Const qualifier

- Const member functions
  - Specify which member functions can be invoked on const objects.

```
const Rational operator+(const Rational& lhs,
                         const Rational& rhs);
```

When operator+ is a member function,
a = b+c is allowed, but what if you want to do
a = c + 2;
a = 2 + c;
Mixed mode operations are the reason why operators are usually defined outside the class.

References

- What is a reference?
  - An alternate name for an object.
  - Frequently used for pass by reference.

```
void swap(int& i, int& j)
{
  int tmp = i;
  i = j;
  j = tmp;
}
```

```
int main()
{
  int x, y;
  ...
  swap(x,y);
  ...
}
```

Here i and j are aliases for main's x and y respectively. In other words, i *is* x — not a pointer to x, nor a copy of x, but x itself. Anything you do to i gets done to x, and vice versa.

References

- A reference is an alias.
  - Int ival = 1024; int &refVal = ival;
  - refVal += 2; // increases ival.
- Errors:
  - int &refVal2 = 10; // a reference must be initialized.
  - Int &refVal3;

Const references

- A reference that refers to a const object.
  - const int ival = 1024;
  - const int& refval = ival;
  - const double& pi = 3.14; // only legal for const references
- Errors:
  - Int &ref2 = ival; // Non-const reference to a const object.

Const references

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

int main(void){
      int dval = 100;
      const int& ref = dval;
      ref++;
      return 0;
}
```

What is wrong?

Type aliasing

using lets us define an alias for a type.

```
using wages = double;
using exam_score = int;
using salary = wages;

Variable definitions:
wages wage1, wage2;
exam_score person1, person2;
```

```
using WEIGHT = struct { int scruples; int drams; int grains; } ;

using WEIGHT = class {
public:
      int scruples; int drams; int grains;
};
```

---

typedef is older syntax for using.

auto

- Type deduction

```
auto item1 = val1 + val2;

int I = 0; &r = I; auto a = r; // a is an int
auto &ra = I; // ra is an int&

auto I; // compilation error

const int ci = I, &cr = ci; auto b = ci; // b is an int, const is dropped
const auto f = ci; // Explicit Const
```

decltype

- Define a variable with a type deduced from an expression

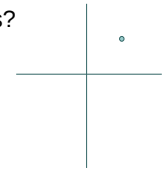
```
decltype(f()) sum = x;

const int ci = 0, &cj = ci;
decltype(ci) x = 0;    // x has type const int
decltype(cj) y = x;    // y has type const int& and is bound to x
decltype(cj) z;        // error: z is a reference and must be initialized

int i;
// decltype of a parenthesized variable is always a reference
decltype((i)) d;       // error : d is an int& and must be initialized
decltype(i) e;         //  e is an uninitialized int
```

Back to the C++ Class

- The C++ Class
  - Similar to a struct
  - Defines what objects of a class are (what attributes describe them)
  - Usually contains functionality in addition to attributes
- The Object
  - An *instance* of a class
  - A variable declared to be of a "class type“
- class member: a component of a class; may be either a data item or a function

Class example

- Write a class to represent a two dimensional point.
- What data attributes do we need?
- What operations?



2D Point class

- Data
  - Position
- Operations
  - Set Position
  - Get Position
  - Distance from another point

Your first class.

Include guards

```
#ifndef POINT2D_HPP
#define POINT2D_HPP

class point2D{
private: int _x,_y;

public:
     void setX(const int val);
     void setY(const int val);
     int getX();
     int getY();
     double double_distance(point2D& p);
} ;

using Cell_tower = Point2D;
using Cell_phone = Point2D;

// Implementation goes here…

#endif
```

Interface

Using the point2D class

```
Point2D p,q;
p.setX(10); p.setY(10);
q.setX(0); q.setY(10);

Cout << “Distance between p and q is “
   << p.distance(q) << endl;
```

Implementing the point2D class.

```
#ifndef POINT2D_HPP
#define POINT2D_HPP

class point2D{
private: int _x,_y;

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

      // … Rest of the interface/implementation…
} ;

using Cell_tower = Point2D;
using Cell_phone = Point2D;

// Implementation goes here…

#endif
```

Implementing the point2D class.

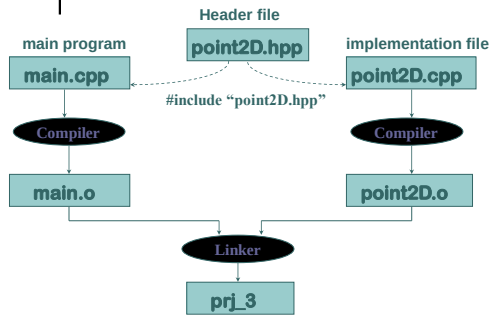
```
#ifndef POINT2D_HPP
#define POINT2D_HPP

class point2D{
private: int _x,_y;

public:
      void setX(const int val);
      // … Rest of the interface/implementation…
} ;

using point2D = Cell_tower;
using point2D = Cell_phone;

// Implementation goes here…
void point2D::setX(const int val){
            _x = val;
}

#endif
```

Can be also implemented in point2D.cpp

Headers

- Always use #include guards
- Do not define variables or functions in headers except
  - Class definitions
  - Const objects
  - Inline functions
- Difference between
  - #include <myfile.h>
  - #include “myfile.h”

Header files



Avoiding Multiple Inclusion of Header Files

- **often several program files use the same header file containing typedef statements, constants, or class type declarations--but, it is a compile-time error to define the same identifier twice**
- **this preprocessor directive syntax is used to avoid the compilation error that would otherwise occur from multiple uses of #include for the same header file**

```
#ifndef  Preprocessor_Identifier
#define  Preprocessor_Identifier
   .
   .        h
   .
#endif
```

Using the boost timer class

```
#include <iostream>
#include <boost/timer.hpp>

using namespace std;

int main(void) {
  boost::timer t;
  std::cout << t.elapsed() << std::endl;
  return 0;
}

// Compile with: g++ -g -Wall -std=c++1y c.cpp
```

A Problem with #define.

- #define max(a,b) ((a) > (b) ? (a) : (b))
- int a = 10, b = 20;
- max(a,b)
- max(++a,b)
- max(++a,b+10)