CH-230-A

Programming in C and C++

C/C++

Tutorial 13

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Abstract Classes (1)

- It should be evident that classes near to the root of the hierarchy are seldom instantiated
  - Very general but also very unspecialized
- Some classes are introduced just to define common behaviors, but are not self sufficient
  - Think of the class shape in one of the former examples
- Those classes are useful only for abstraction

Abstract Classes (2)

- Abstract classes define a set of methods to be shared by a derived class but are not yet implemented
  - Implementation will be defined in a derived class
    - Virtual mechanism plays a fundamental role
- A pure virtual method is a method declared as:

```
virtual void something() = 0;
```

- A class having one or more pure virtual methods is abstract

Abstract Classes (3)

- Abstract classes cannot be instantiated
- Abstract classes can also include non-pure virtual methods
- Methods and functions can accept pointers to abstract classes
  - This is their main use: through virtual calls generic code is developed

Shapes Example Revised

- In the shape example the shape class has not actually represented a shape (instance), but rather collected some data common to all shapes
- Therefore, `Shape` is a good candidate to be an abstract class
  - `shapesrevised.h`
  - `shapesrevised.cpp`
  - `testshapesrevised.cpp`

Virtual Destructors?

Destructors are almost always `virtual`

- If you are manipulating objects via pointers to the base class, then the base class should define its destructor as `virtual`
- Otherwise just the base class destructor is called
- Recall that destructors are called from bottom to up
- Destructors can be pure `virtual`
  - There are some subtle details concerning this aspect (see Eckel's book, chapter 15)

Virtual Constructors?

- You cannot have virtual constructors
  - Remember that constructors are called from the base to the leaves of the derivation tree
- Inside a constructor you can call a virtual method, but this will execute the local version
  - No downsearch is performed, as the assembly of the object is still being performed and elements belonging to derived classes are not guaranteed to be properly initialized

Overloading Operators for Casting

- It is possible to create operators for converting a type to another, thus performing a sort of casting
  `operatorconversion.cpp`
- This can also be done by implementing an ad-hoc constructor taking the type we want convert from
  `constructorconversion.cpp`

The `explicit` Keyword

- If a constructor is declared with the explicit modifier, it will be used for type conversion only if the typename is explicitly inserted
- Then it is possible to choose which kind of conversion will take place: constructor driven or operator driven

`explicitconversion.cpp`

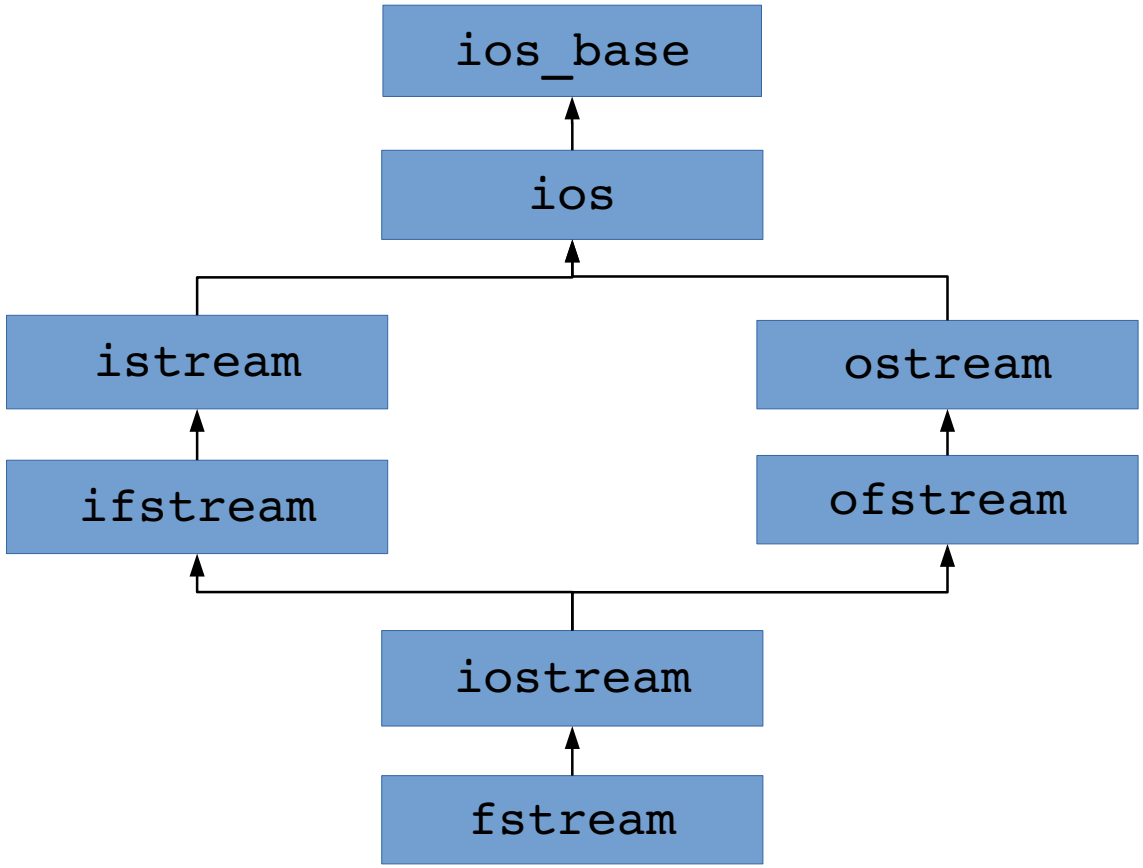
Streams

- A stream is a flow of data from a source to a destination
  - Widely used concept in Unix
  - Think to water flowing in a pipe
- Standard C++ provides classes for handling streams of data connected to the console or to files
  - Common interface: learn once use everywhere

Iostreams

- You already used them
- The instances `cin`, `cout` and `cerr` are declared in the header files included in `<iostream>`
- Exceptional use due to their wide use
  - Preprocessor directives for conditional compiling avoid multi-declaration problems
- Extractors and inserters are overloaded operators designed to work with different data types
  - Consider to overload them to work with your own developed classes

Class Hierarchy



Output Streams and the Inserter Operator <<

- Operator << has been overloaded to work with all language data types and many classes
  - It sends data to an output stream (`ostream`)
- Inserters can be concatenated
- Additionally, manipulators can modify the output
  - `endl`, `flush`, `hex`, `oct`, `dec`
    Example: `cout << hex << "0x" << 34 << flush;`

The << Operator

- Converts internal data type into sequence of ASCII characters

```
ostream& operator<<(const char *)
ostream& operator<<(char)
ostream& operator<<(int)
ostream& operator<<(float)
ostream& operator<<(double)
```

- Returns reference to `ostream`

Input Streams and the Extractor Operator >>

- The operator >> has been overloaded to work with predefined language data types
  - It gets data from an input stream (`istream`)
- Extractor stops reading when it finds a whitespace
- The manipulator `ws` removes leading and trailing white space from an `istream`

Line Oriented Input

- Istreams provide two methods to get a whole line of text:
  - `get()` get the text but do not remove the delimiter
  - `getline()` get the text and remove the delimiter
  - Both accept three parameters: char buffer to store data, buffersize and terminator character
  - Default value of terminator is `'\n'`
- It can be useful to grab input as a char sequence and then convert it using C functions

Raw I/O

- Binary files: images, audio, self-defined formats, etc.
- Raw I/O member functions are used to write/read binary data to/from streams
  - Istreams:
    - `read(char *, int)`
    - `gcount()` returns the number of characters extracted
  - Ostreams:
    - `write(char *, int)`

The State of a Stream

The following member functions can be used to investigate on the state of a stream:

- `good()` true if `goodbit` is the current state
- `eof()` true if `endoffile`
- `fail()` true if `failbit` or `badbit` set
- `bad()` true if `badbit` set
- `clear()` set state to `goodbit`

File Streams

`ifstream` and `ofstream` classes can be used to connect a stream to a file

- Just provide the name of the file as a parameter to the constructor
- You do not need to open or close the file (up to constructor and destructor)
- Classes are declared in the `fstream` header file
- `filestream.cpp`

Open Mode Flags

Flag	Function
`ios::in`	Open as input
`ios::out`	Open as output
`ios::binary`	Open in binary mode
`ios::app`	Open for appending
`ios::ate`	Open and go at end
`ios::trunc`	Open and delete the old if present

Overloading Extractors and Inserters for your Types

- It can be useful to overload << and >> to dump and/or read classes instances to streams
  - For example to save/retrieve the state of the application to/from a file
- Add an overloaded operator << or >> definition to the class
  - Should be `friend`
  - Returns an `ostream`/`istream` reference
  - Should take an `istream`/`ostream` reference and a (`const`) reference to the class as parameters
  - `overloadedstream.cpp`