

Introduction to C++

History

- ◆ C++ is an object-oriented extension of C
- ◆ C was designed by Dennis Ritchie at Bell Labs
 - used to write Unix
 - based on BCPL
- ◆ C++ designed by Bjarne Stroustrup at Bell Labs
 - His original interest at Bell was research on simulation
 - Early extensions to C are based primarily on Simula
 - Called “C with classes” in early 1980’s
 - Popularity increased in late 1980’s and early 1990’s
 - Features were added incrementally
 - Classes, templates, exceptions, multiple inheritance, type tests...

Design Goals

- ◆ Provide object-oriented features in C-based language, without compromising efficiency
 - Backwards compatibility with C
 - Better static type checking
 - Data abstraction
 - Objects and classes
 - Prefer efficiency of compiled code where possible
- ◆ Important principle
 - If you do not use a feature, your compiled code should be as efficient as if the language did not include the feature.

What is Data Abstraction?

◆ Abstract Data Types (ADTs)

- type implementation & operations
- hidden implementation

◆ types are central to problem solving

◆ a weapon against complexity

◆ built-in *and* user-defined types are ADTs

How Well are ADTs Supported in C?

C?

◆ Does **C** enforce the use of the ADTs interface and the hiding of its implementation?

◆ *No*

C++

- ◆ C++ is a superset of C, which has added features to support **object-oriented programming**
- ◆ C++ supports **classes**
 - things very like ADTs

How successful?

- ◆ Given the design goals and constraints,
 - this is a very well-designed language
- ◆ Many users -- tremendous popular success
- ◆ However, very complicated design
 - Many specific properties with complex behavior
 - Difficult to predict from basic principles
 - Most serious users chose subset of language
 - Full language is complex and unpredictable
 - Many implementation-dependent properties
 - Language for adventure game fans

Email discussion group

comment

... in my group ... we do use C++ regularly and find it very useful but certainly not perfect. Every full moon, however, we sacrifice a virgin disk to the language gods in hopes that the True Object-Oriented Language will someday be manifest on earth, or at least on all major platforms. :-)

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Further evidence

- ◆ Many style guides for using C++ “safely”
- ◆ Every group I’ve ever talked to has established some conventions and prohibitions among themselves.
 - don’t inherit implementation
 - SGI compiler group -- no virtual functions
 - Others

Significant constraints

- ◆ C has specific machine model
 - Access to underlying architecture
- ◆ No garbage collection
 - Consistent with goal of efficiency
 - Need to manage object memory explicitly
- ◆ Local variables stored in activation records
 - Objects treated as generalization of structs, so some objects may be allocated on stack
 - Stack/heap difference is visible to programmer

Overview of C++

- ◆ Additions and changes not related to objects
 - type bool
 - pass-by-reference & the Copy-Constructor
 - user-defined overloading
 - function template
 - exception handling
 - ...

OO Programming Languages

Four main concepts:

- 1. Abstraction:** implementation details hidden inside a program unit with a specific *interface*. The interface is a set of public functions (or methods) over hidden data.
- 2. Inheritance:** reusing the definition of one kind of object to define another kind of object.
- 3. Dynamic lookup:** a method is selected at run time, according to the *implementation* of the object, not some static property of the pointer/var used to name the object.
- 4. Subtyping** is a relation on types that allows values (or objects) of one type to be used in place of values (or objects) of another.

Inheritance Is Not Subtyping!

“Subtyping is a relation on interfaces, inheritance is a relation on implementations.”

C++ Object System

◆ Object-oriented features

1. Classes and Data Abstraction
2. Encapsulation
3. Inheritance
 - Single and multiple inheritance
 - Public and private base classes
4. Objects, with dynamic lookup of virtual functions
5. Subtyping
 - Tied to inheritance mechanism
 - A will be recognized by the compiler as a subtype of B only if B is a public base class of A