Java-C++ Comparison

- A refresher in OO language features
- Ask questions!

Yannis Smaragdakis

Differences at a Glance

Java eliminates some of the C++ complexities

- No preprocessor (`#define`, `#include`, `#ifdef`)
  - no biggie? (`cpp -P` and some shell stuff)
- No direct memory access (pointers to existing storage)
- No multiple inheritance
- No operator overloading, no implicit conversions
- No `goto`, `free`, `typedef`
- No unions
- No stand-alone functions, global variables

Differences at a Glance

Java adds some things to C++

- Interfaces
- Garbage collection
- `Object`, reflection
- Threading (and monitors) in the language
- Bound/cast checking

Java does many things differently

- Packages, inner classes
- Arrays
- Templates vs. generics
- Incremental compilation
- Virtual machine and bytecode

Interesting Changes: Packages

- Java has no global variables and functions
  - everything is part of a class
- Java packages are a module mechanism, like C++ namespaces
  - unlike modules in other languages, namespaces and packages are *open*
- Access specifiers:
  - for packages, `public` or private (by omitting public)
  - for classes, `private`, `public`, `protected`, or package-protected (by omitting all access specifiers)

References

- Java has no pointers to memory—objects and arrays are always passed “by reference-value”
  - “by reference” is another term used, but it’s overloaded (e.g., C++ reference types have the textbook “by reference” semantics)
    - what is the difference? How do C++ references and const references work? How are Java primitives passed?
- This has some side-effects:
  - copying can be done only with the `clone` method (on `Cloneable` types)
  - deep equality can be tested only with the `equals` method (or equivalent)
  - no direct access to memory, no pointer arithmetic, reference types treated differently than primitive types

Garbage Collection

- Java has no explicit `free` statement, memory is reclaimed automatically
- A "finalizer" *may* be called
- What's wrong with never reclaiming any memory?
  - address space "real estate" is cheap, isn't it?
- Does this mean there can be no memory leaks?
  - a field is not set to `null`, expecting to be overwritten in the future
  - a local variable is not set to `null`, expecting to go out of scope soon
    - a problem in long-running methods
  - Swing/AWT listener that is not removed after it is no longer needed (either by fault of user code or by fault of system code)
  - caching strategy makes objects become unreachable more slowly

Arrays

- No support for multidimensional arrays: they are just arrays of arrays
  - this is not the same in C/C++, despite the similar syntax: an array of pointers to arrays is what's closest to Java
    - think of the memory layout and recall that multidimensional arrays is where the array/pointer duality breaks in C
- Interesting syntax:
  - `byte f[][] = new byte[128][16]`
  - `int i[][] = new int[100][]`
- Arrays are *covariant*:
  if the following is legal,
  `B b; A a = b;`
  then the following is also legal
  `A a[] = new B[];`

Threads and Monitors

- Monitor-style concurrent programming:
  - using mutexes for exclusion from a critical section
  - using conditions (i.e., `wait` statements) for protected waiting
    - used for inclusion in a critical section
- Java supports concurrent programming with threads and monitors at the language level
  - `synchronized` keyword
  - “friendly” thread library

Method Overriding

- A method with the same signature can be defined and it *overrides* the superclass method
  - the new method is called for objects of the subclass

(what's the difference with "overloading"?)

- Pre-Java-5, overriding method needed to have the exact same signature as the original (*non-variance*)

- In current Java (as in C++) the return type can be more specific (*covariance*)

Interfaces

- Interfaces partially describe the signature of a class
  - not sufficient for static type checking, unfortunately: no nested classes, no constructors, no `final` attributes, etc.
- Interface conformance needs to be explicitly declared (*named*, not *structural* conformance)
- Interfaces used to eliminate a common need for multiple inheritance

C++ Templates (10 mile-high view)

- Class templates:

```
template <class E1, class E2>
struct Pair {
  E1 fst;
  E2 snd;
 ...
};
```

- Function templates:

```
template <class T>
const T& max(const T& e1, const T& e2)
{
  if (e1 > e2)
    return e1;
  else
    return e2;
}
```

- Templates: a full sub-language for compile-time computation

C++ Operator Overloading and Implicit Conversions

- Advanced features from a language design point of view
    - they are essentially extensibility features for C++ compilers
    - can be used to redefine the syntax and the type system of the language
- Overloading:

```
struct F {
 ...
  int operator[] (int index) {...}
};
```

- Implicit conversion:

```
class F {
  operator int() const {return 1;}
};
```


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