CSE 341: Programming Languages

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Lecture 25—Named Types; Class vs. Types; Interfaces
Named Types

In Java/C++/C#/..., types don’t look like \([t_{10} \ m_{1}:(t_{11},\ldots),\ldots, \ t_{n_{0}} \ m_{n}(t_{n_{1}},\ldots)]\).

Instead they look like \(C\) where \(C\) is a class or interface.

But everything we just learned about subtyping still applies!

Yet the only subtyping is (the transitive closure of) declared subtypes (e.g., class \(C\) extends \(D\) implements \(I,J\)).

Given types \(D, I,\) and \(J\), ensure objects produced by class \(C\)’s constructors can have subtypes (more methods, contra/co, etc.)
Named vs. Unnamed

For preventing “message not understood”, unnamed (“structural”) types worked fine.

But many languages have named (“nominal”) types.

Which is better is a tired old argument, but fortunately it has some interesting intellectual points (unlike emacs vs. vi).

First, frame the question more narrowly: Should subtyping be nominal or structural? (Named types don’t preclude structural subtyping, e.g. casting between two otherwise-unrelated interfaces.)
Some Fair Points

For structural subtyping:

- Allows more code reuse, while remaining sound.
- Does not require refactoring or adding “implements clauses” later when you discover you could share some implementation.
- A simpler system (type names are just an abbreviation and convenient way to write recursive types)

For nominal subtyping:

- Reject more code, which catches bugs and treating unmeaningful method-name clashes as significant.
- Confusion with classes saves keystrokes and “doing everything twice”?
- Fewer subtypes makes type-checking (?) and efficient code-generation easier.
The Grand Confusion

For convenience, many languages *confuse* classes and types:

- C is a class and a type
- If C extends D, then:
  - instances of the class C inherit from the class D
  - expressions of type C can be subsumed to have type D

Do you usually want this confusion? Probably.

Do you always want “subclass implies subtype”? 

- No: Recall distTo for Point and 3DPoint.

Do you always want “subtype implies subclass”? 

- No: Two classes with display methods may no inheritance relationship.
Untangling Classes and Types

- Classes define object behavior; subclassing inherits behavior
- Subtyping defines substitutability
- You often want subclasses to be subtypes; most languages give you no choice.

Now some other common features make more sense:

- “Abstract” methods:
  - Expand the supertype without providing behavior to subclass
  - Superclass does not implement behavior, so no constructors allowed (an additional static check because the class is abstract)
  - The static-check is the only fundamental justification (trivial to provide a method that raises an exception).

- Interfaces...
Interfaces

A Java interface is just a (named) object type.

By implementing an interface, you get subsumption but no behavior.

• Same thing with “multiple inheritance” when \( n - 1 \) superclasses have all abstract methods. Should be called “multiple subsumance”, but subsumance is not a word. :) 

• None of the semantic issues we previously discussed with multiple inheritance arise with interfaces.

• But there are issues we didn’t discuss before because they’re about typing, and we’ll skip now:
  – Lack of least supertypes 
  – Ambiguity if “subsumption is not a run-time no-op” (coercive)