Overloading Implies Rules for Matching Calls to Functions

Since functions can be overloaded,
◦ a compiler must have rules
◦ for choosing amongst functions
◦ with the same name.
Let's first ask: how different
◦ do two definitions of a function need to be
◦ for the compiler to distinguish them?

C++ Supports Extremely Minor Variations

High-level answer:
◦ C++ allows for extremely minor variations;
◦ use them at your own risk.
Variations on functions
◦ are not much different
◦ than naming two variables
◦ VaRiAbLe and vArIaBlE.

C++ Distinguishes Between Similar Types

For example,
◦ C's default conversions are not assumed,
◦ so the following can be differentiated:
  \[
  \text{int operator+= (int i);} \\
  \text{int operator+= (char c);} \\
  \]
One can also distinguish
◦ between signed and unsigned values,
◦ between const and non-const values,
◦ and so forth.
Matching Happens on a Per-Argument Basis

How does a compiler choose?
The basic rule:
- pick the “most derived” class
- for each argument.
The result is not always unique, as you already know.
Compilers report errors if the results are ambiguous.

Pitfall: Overloading too Finely Can Confuse Users

Exact rules exist, but don’t seem to be widely known, understood, portable, and so forth.*

My advice: as with precedence,
- if you don’t know the answer,
- don’t try to look it up:
  - instead, avoid using it.
Matching overloaded calls is much more dangerous—one can ‘steal’ calls from existing code by creating new functions that provide better matches.

*See ECE409 notes L7P5-6 for more detailed comments, or the C++ ARM or standards for a definitive version.

Some Operators Cannot be Overloaded

C++ allows most, but not all, operators to be overloaded.
Operators that cannot be overloaded include
- member access ("."),
- pointer to member function invocation (".*"),
- conditional expressions ("? :"), and
- scope identification ("::").

C Equivalences May Not Be Valid in C++

In C++, C’s equivalences may no longer hold.
For example, pointer-like and array-like objects are not necessarily the same
- array[10] (calls operator[])
- may not be the same as
  - *(array + 10) (calls operator+ and operator*).
These operators can be defined to be consistent, however.
Some Expressions Cannot Be Made Equivalent

Other equivalences cannot be made consistent if overloading is used to substantially change some operators.

For example, pointer dereference:
- `inst->member`
- `(*inst).member`
- `inst[0].member`

The latter two expressions use `.` which cannot be overloaded.

Assignment Requires First Destroying the Old Instance

Similarly, given `ALPHA a;`

the following are not equivalent:
- `ALPHA b = a; // copy constructor`
- `b = a; // operator= (assignment)`

For a new variable, the first version is better:
- `work` may be required to destroy `b`
- (for example, removing `b` from a sorted list or a binary search tree).
- before copying the new value from `a`.

Copy Constructor and Assignment not Equivalent in C++

Note that
- the copy constructor and
- assignment (operator=) are not equivalent in C++.

The default versions are the same (copy constructor detailed in earlier slides), but
- overriding one does NOT override the other,
- which continues to use the default version
- and compilers will NOT warn you.

Treating Instances as C Variables Generates Useless Work

One last topic: variable declarations and single-assignment.

C++ instances are “always” valid:
- constructed when they are declared, and
- destructed when they leave scope (and can no longer be accessed).

Treating them as C variables generates useless work by forcing initialization before information for initialization is available.
C++ Allows Variable Declarations Between Statements

To address the problem, C++
- allows variable declarations
  - to be interleaved with statements
- (later, this feature was back-propagated into C).

for loop iteration variables
- of a single base type
- can also be declared in the init clause
- (not supported for other loops).

Avoiding Extra Work with Conditionals Still Tricky

The problem is not completely solved: consider the code below.

```c
int choice = some_calculation ();
if (choice) {
  // use constructor 1 for var
} else {
  // use constructor 2 for var
}
// use var ...
```

Op-Assign Operators Should Be Used When Possible

Use of op-assign operators
- +=, -=, *=, and so forth
- is also encouraged in C++.

Why?

- Are these all the same?
  - A = A + B
  - A = B + A
  - A += B

One answer: not if + is string concatenation.

Compilers May Fail to Perform “Obvious” Optimizations

Even restricting our attention to \( A = A + B \), proving equivalence may be challenging.

A compiler
- must consider aliasing:
  - can A be changed before the sum operation is complete?

Compiler can analyze the problem
- if both functions, and
- may be able to transform into \( A += B \).

In contrast, programmer must handle aliasing when implementing `operator+=`. 