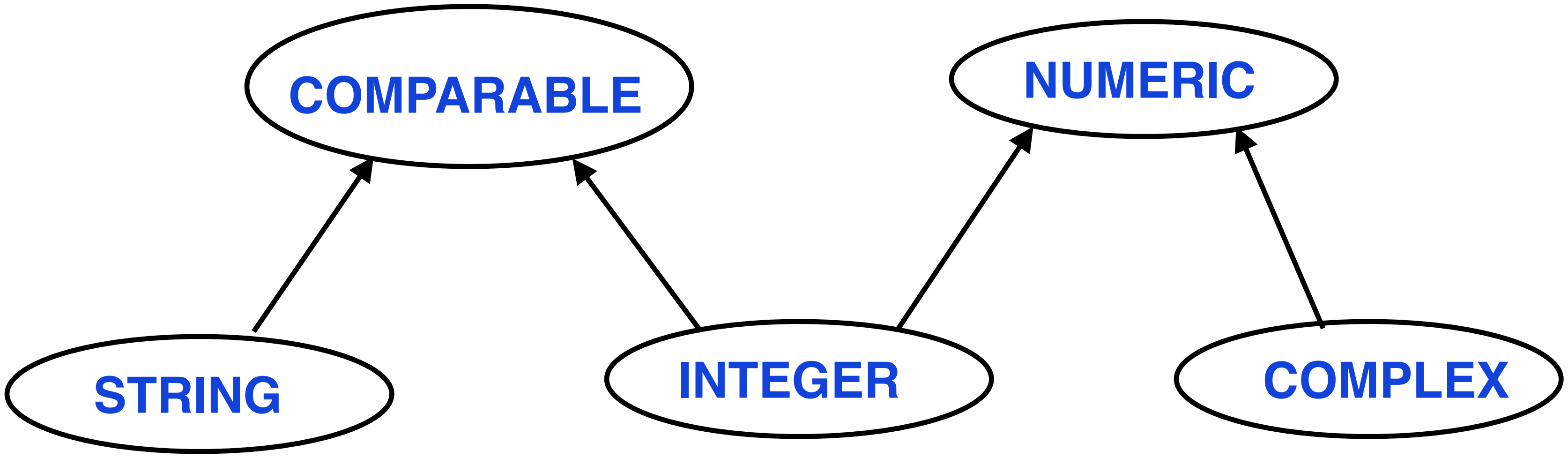
Multiple & Repeated Inheritance

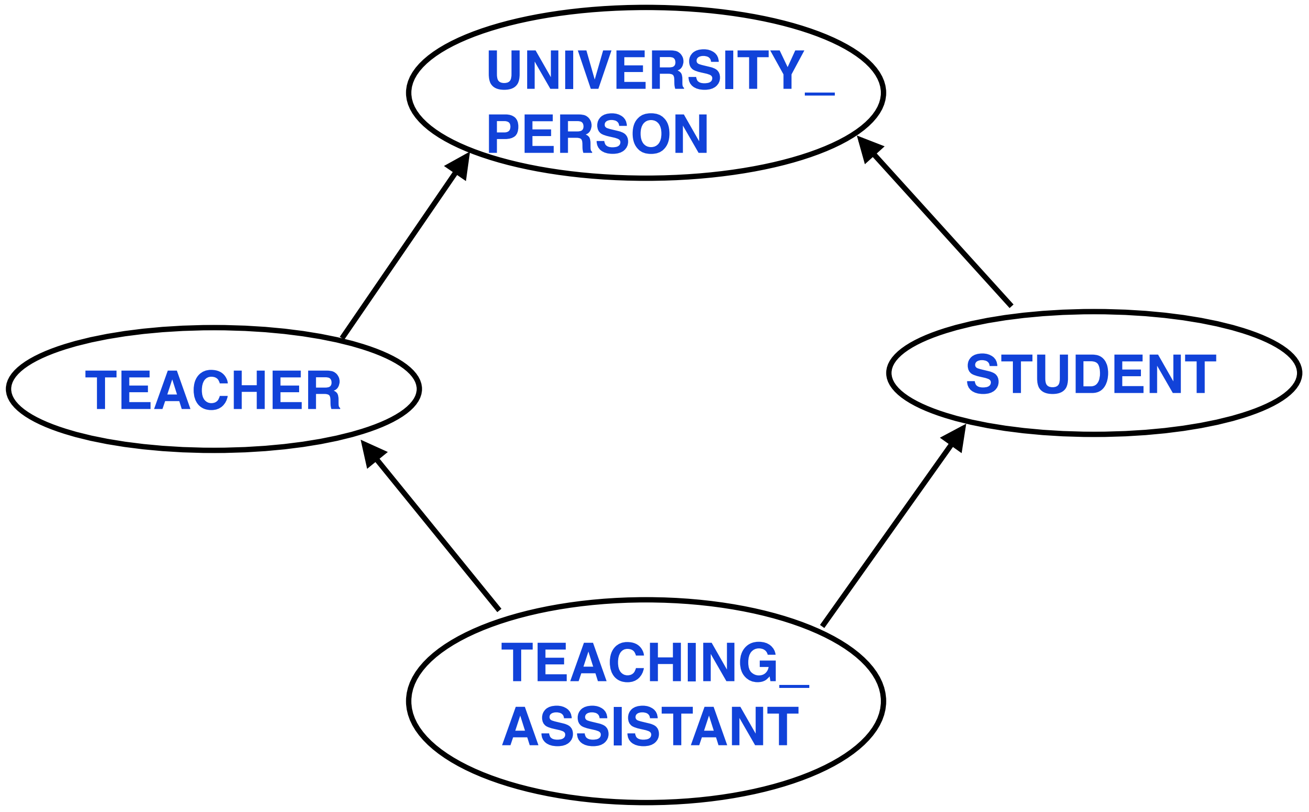
Multiple Inheritance – Example

- Combining two abstractions into one
  - » **COMPARABLE and NUMERIC are both useful abstractions**
    - > **Some abstractions make use of both while others do not**



Repeated Inheritance – Example

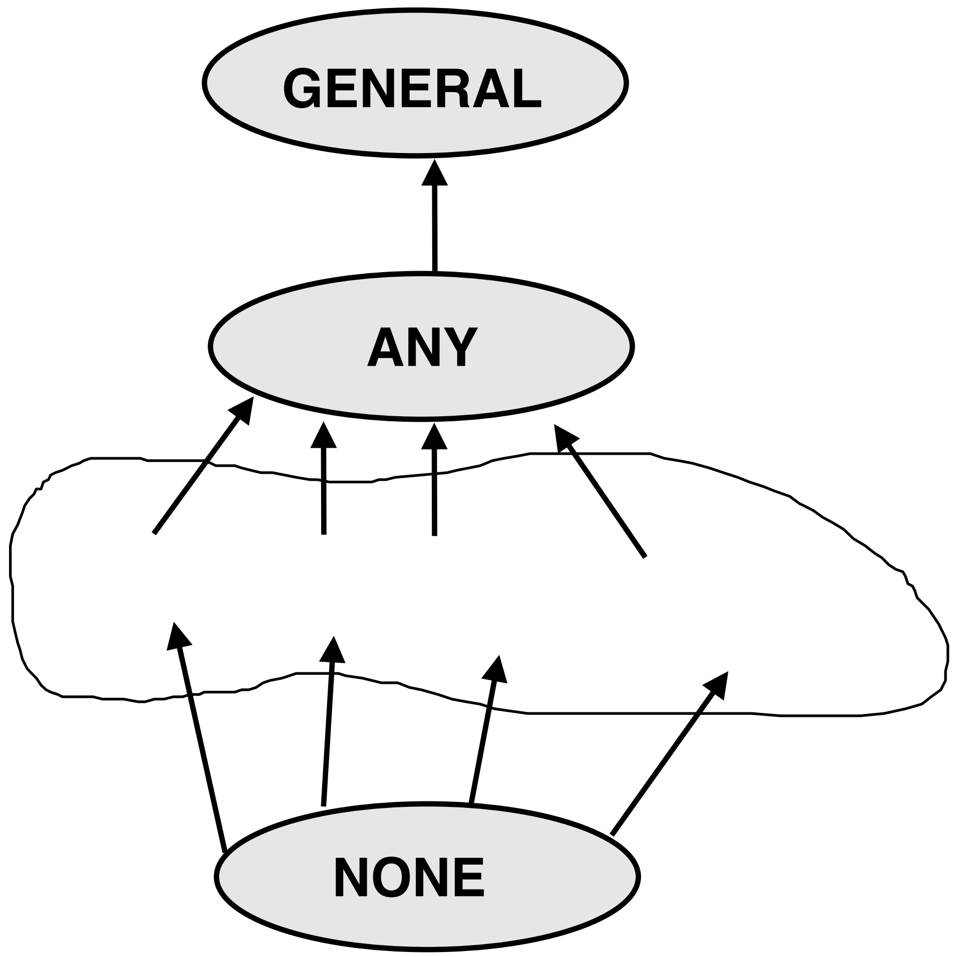
- Ancestor used in multiple paths to descendant



Inheritance Types

- **Implementation** – abstraction that combines two implementations
  - » **ARRAY_STACK is both a STACK and and ARRAY**
- **Structural** – abstraction that combines two structures
  - » **HISTORY and STORABLE**

Eiffel Global Inheritance Structure



GENERAL has all Eiffel global features & invariants

Customize ANY to have localized global features & invariants

Feature Renaming

- Multiple & repeated inheritance lead to name clashes

Feature Renaming – 2

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  - » **What if two parents use the same name for a feature?**

Feature Renaming – 3

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    - > **A common occurrence since good names are reused**

Feature Renaming – 4

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    - > **A common occurrence since good names are reused**
  - » **How can the child refer to the appropriate feature?**

Feature Renaming – 5

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  - » **How can the child refer to the appropriate feature?**
    - > **Rename one of the features – give it an alias**

Feature Renaming – 6

- Multiple & repeated inheritance lead to name clashes
  - **What if two parents use the same name for a feature?**
    - **A common occurrence since good names are reused**
  - **How can the child refer to the appropriate feature?**
    - **Rename one of the features – give it an alias**
    - **Do not rely on overloading, not enough variation**
      - **Overloading - distinguishes features by argument type and count**

Example Renaming

- Suppose **LONDON** and **LOS_ANGELES** both have the feature **foo**
- Then define **TORONTO** as follows

```
class TORONTO inherit
    LONDON
            rename foo as fog
            redefine fog end
    LOS_ANGELES
            rename foo as smog
            redefine smog end
feature
    ...
end
```

Renaming Effects

ldon : LONDON ; la : LOS_ANGELES ; tor : TORONTO

Valid – even after polymorphic assignment

```
ldon.foo  ;  tor.fog
la.foo    ;  tor.smog
```

Invalid

```
ldon.fog  ;  ldon.smog
la.fog    ;  la.smog
tor.foo
```

Redeclaration & Renaming

- Redeclaration
  - » **Keeps the name, changes the semantics**

Redeclaration & Renaming – 2

- Redeclaration
  - » **Keeps the name, changes the semantics**
- Renaming
  - » **Keeps the semantics changes the name**

Redeclaration & Renaming – 3

- Redeclaration
  - » **Keeps the name, changes the semantics**
- Renaming
  - » **Keeps the semantics changes the name**
- Can both rename and redefine
  - » **Rename first**
  - » **Use new name when redefining**

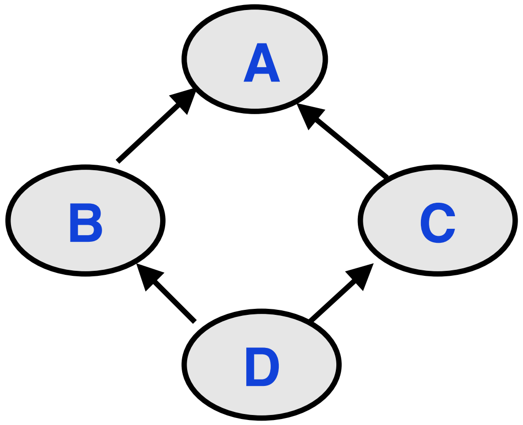
Redeclaration & Renaming – 2

- Renaming can be useful to change the name to a more common one for the abstraction

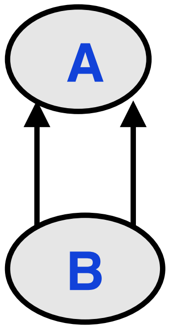
» **TO**	**push & pop (STACK)**
FROM	**add and remove (CONTAINER)**

Repeated Inheritance

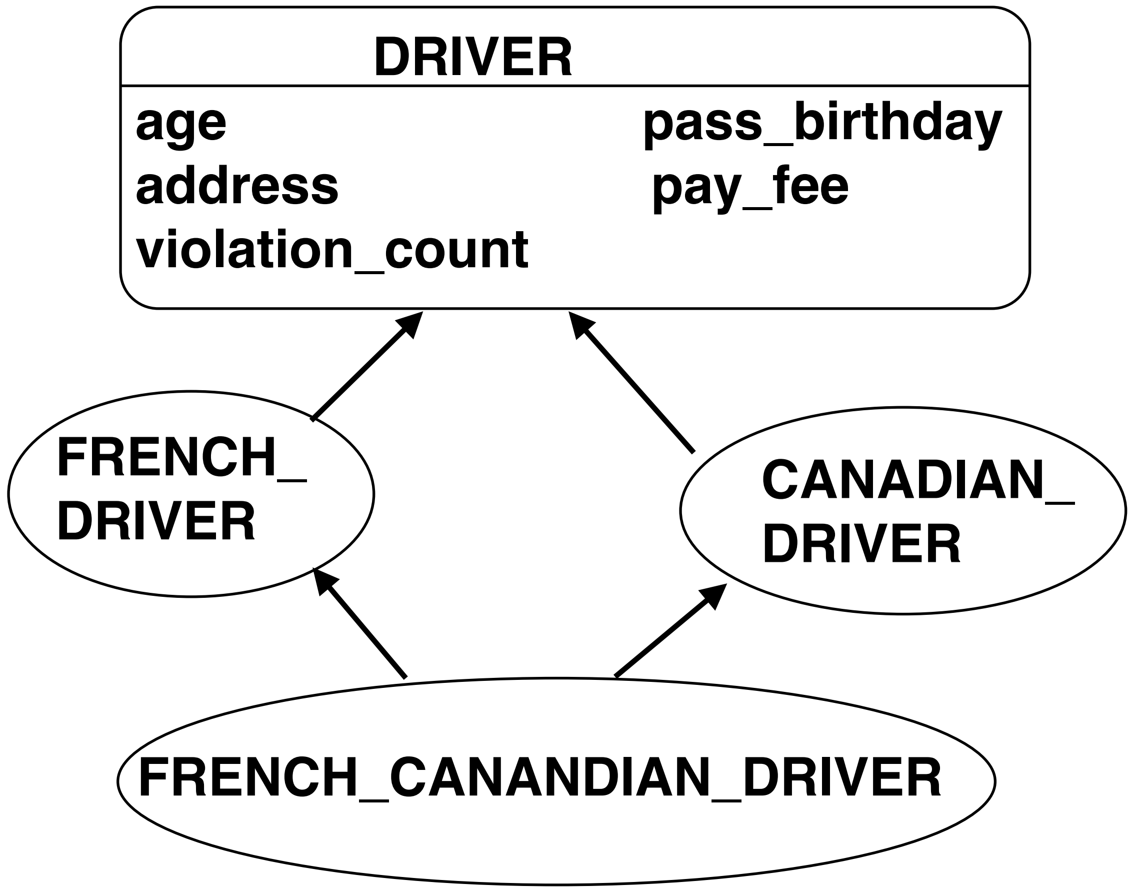
- Indirect
  - » class B inherit A
    class C inherit A
    class D inherit B C



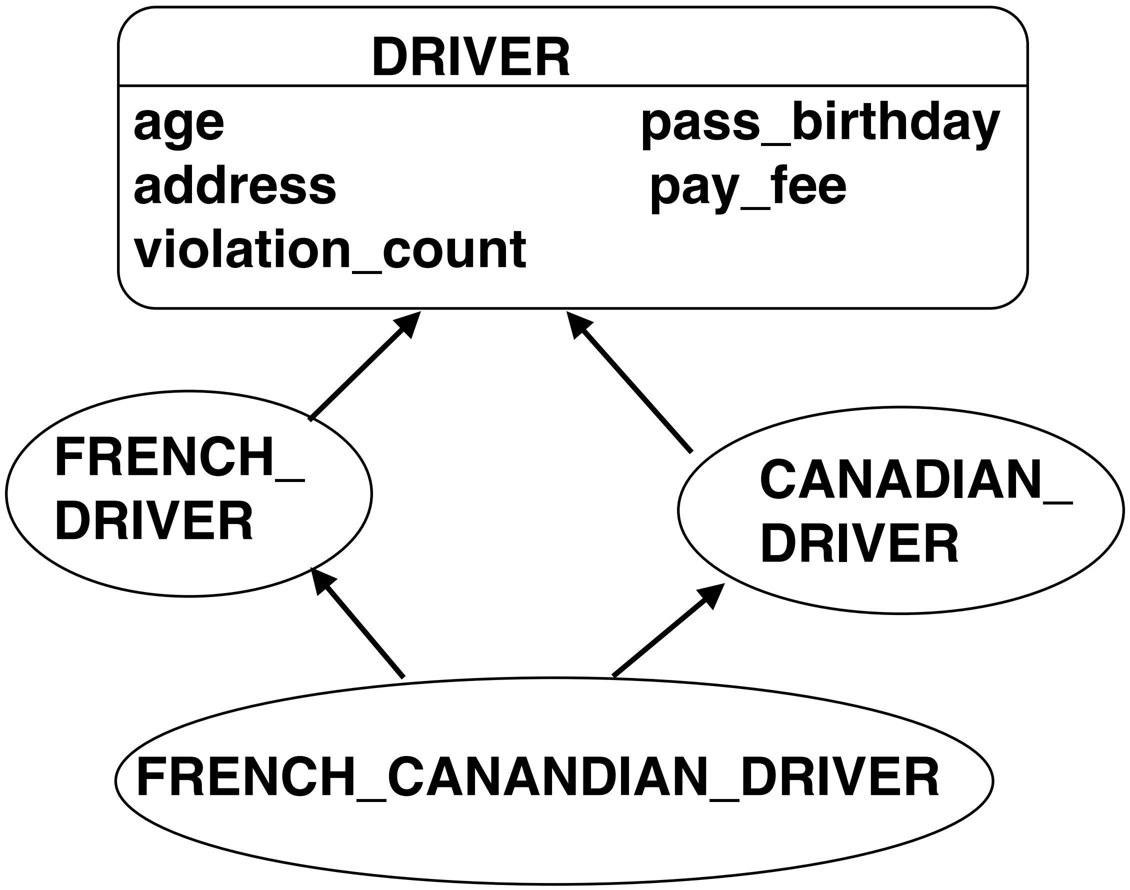
- Direct
  - » class B
        inherit
          A
          A



Problems


DRIVER
age
address
violation_count
pass_birthday
pay_fee
FRENCH_
DRIVER
CANADIAN_
DRIVER
FRENCH_CANANDIAN_DRIVER

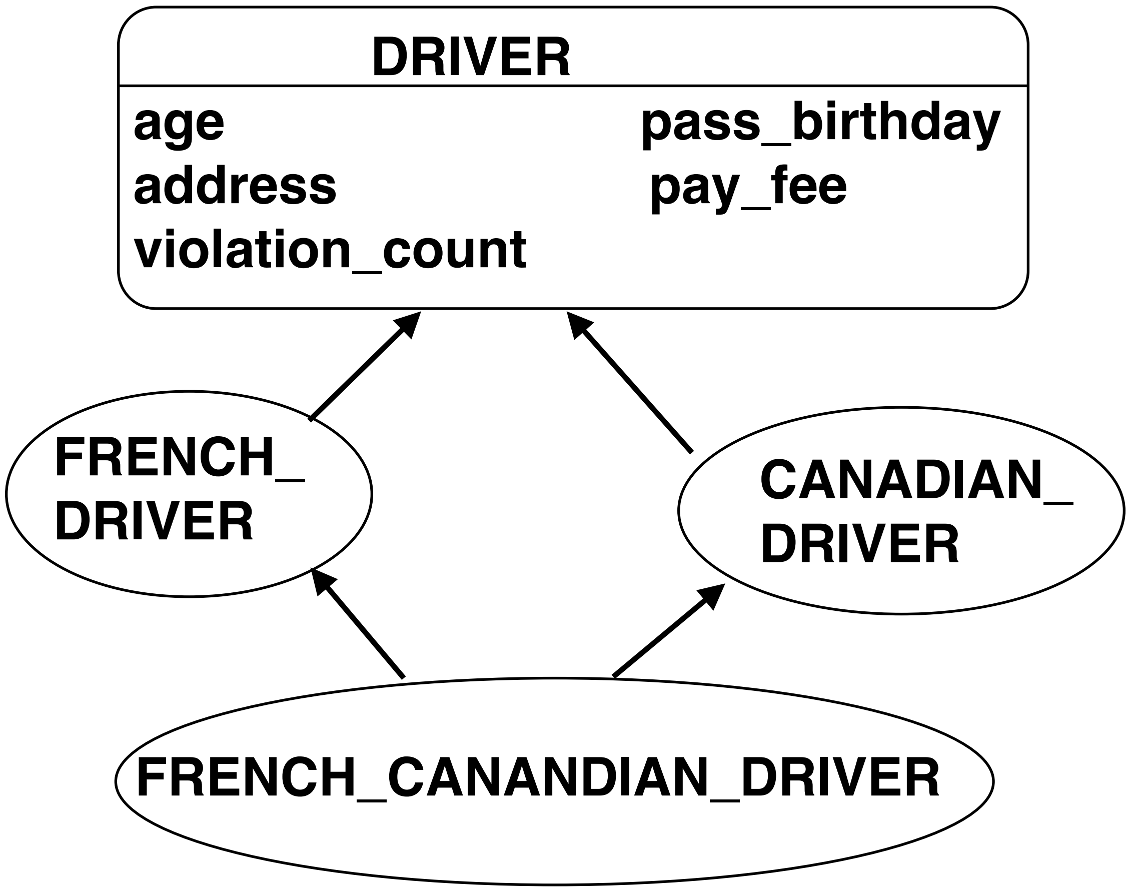
Problems – 2



What about age?

It is the same along both paths?

Problems – 3



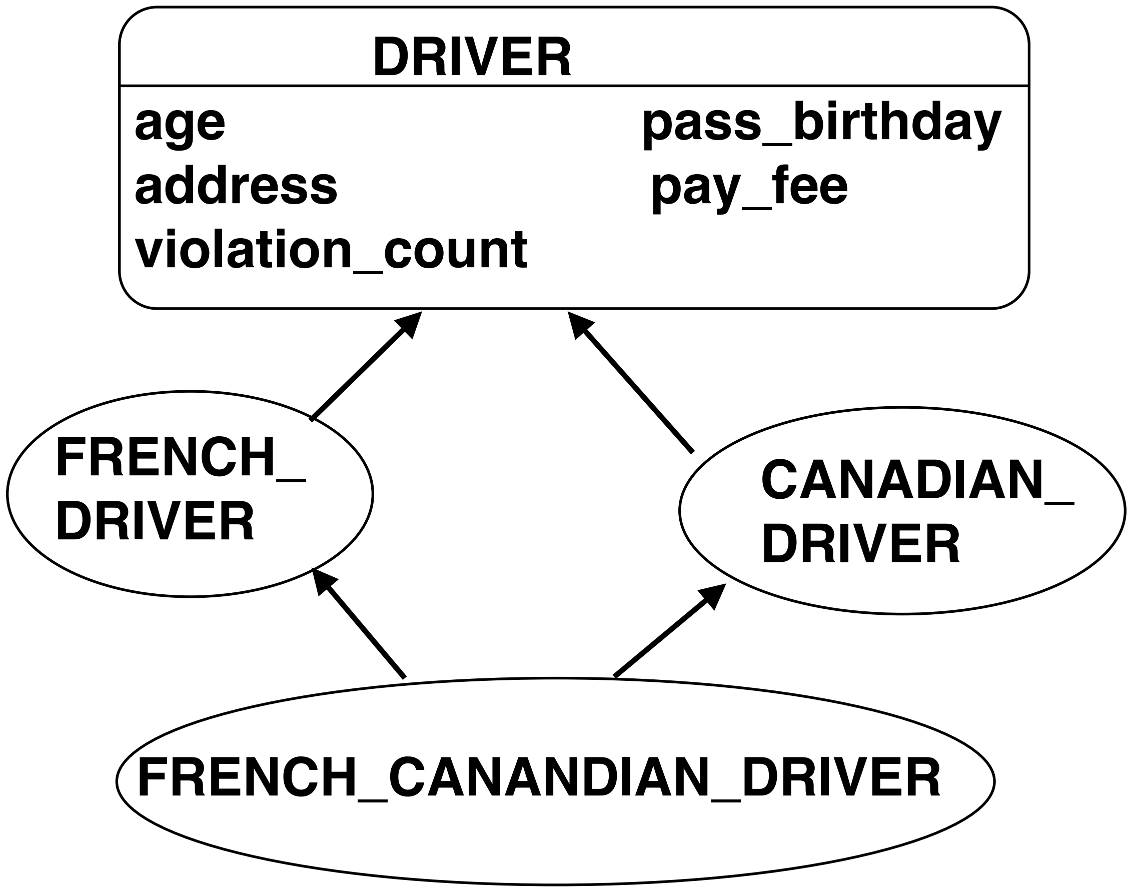
What about age?
It is the same along both paths ?

DO NOT rename!

Only rename if inheriting different but identically named features

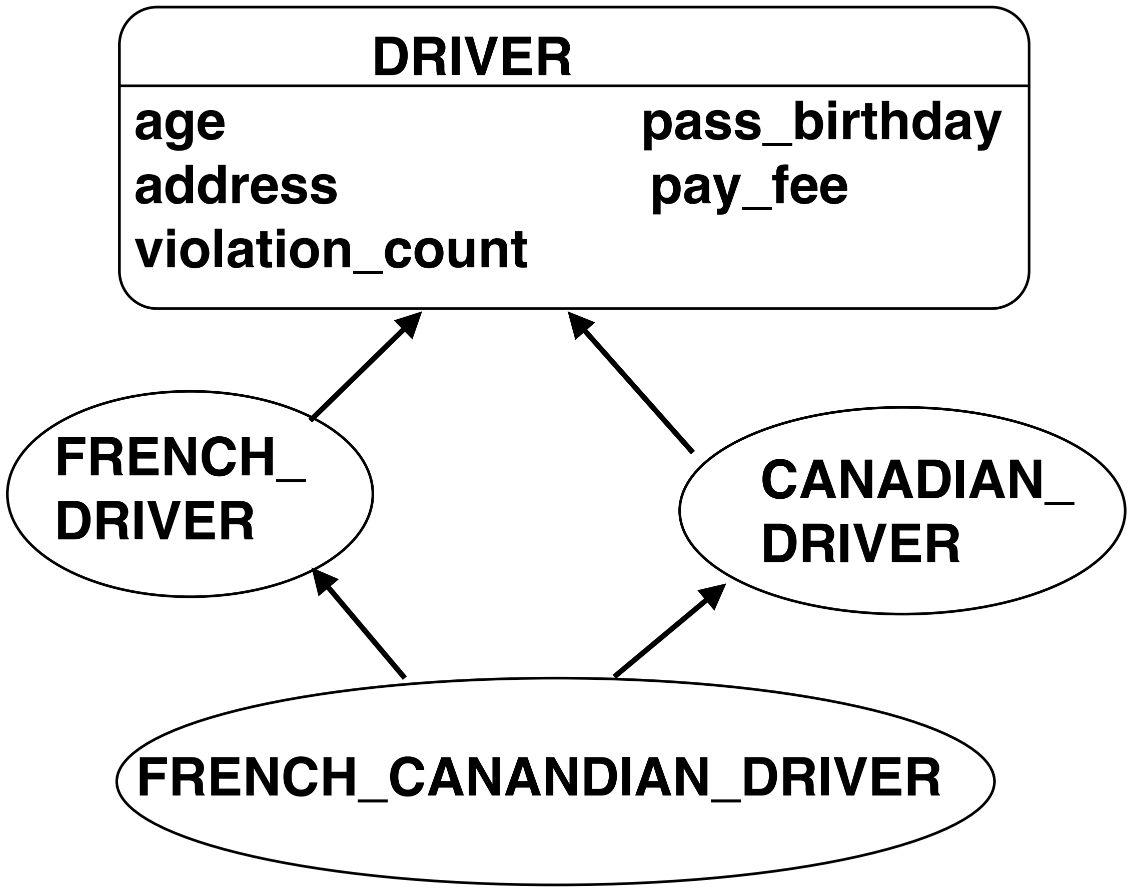
Have a single shared feature

Problems – 4



What about violation_count, address, pay_fee?

Problems – 5



What about violation_count, address, pay_fee?

Sharing is not always appropriate. These are different along each path.

Need to replicate for each driver

Repeated Inheritance Rule

Versions of a repeatedly inherited feature inherited under the same name represent a single feature

Repeated Inheritance Rule – 2

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Versions inherited under different names represent separate features, each replicated from the original in the common ancestor

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> **Use rename to get replication**
>
> – **rename pay_fee as pay_french_fee**

- The rule applies to routines as well as attributes

Final Name

- Definition
  - » The final name of a feature in a class is
    - > For an immediate feature, the name under which it is declared

Final Name – 2

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Final Name – 3

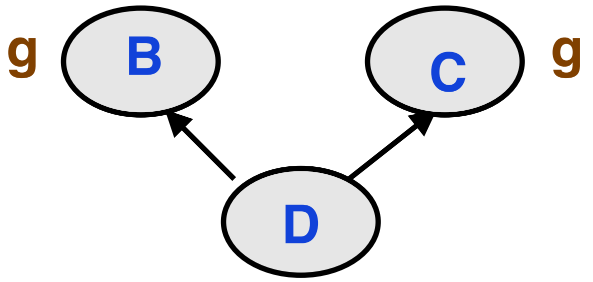
- Definition
  - **The final name of a feature in a class is**
    - **For an immediate feature, the name under which it is declared**
    - **For an inherited feature that is not renamed, its final name is (recursively) in the parent from which it is inherited**
    - **For a renamed feature, the name resulting from the renaming**

Single Name Rule

Two different effective features of a class may not have the same final name

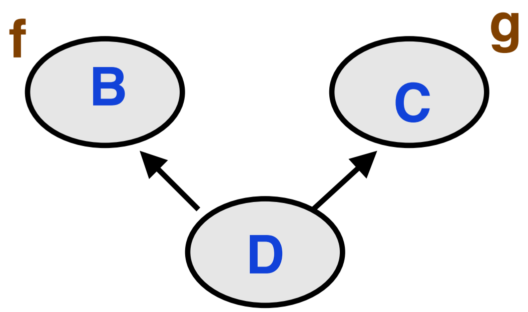
Conflict Resolution – Must Rename

- If there are incompatible signatures or semantics
  - » **Rename g in D**
    - > **Either from B or C or both**



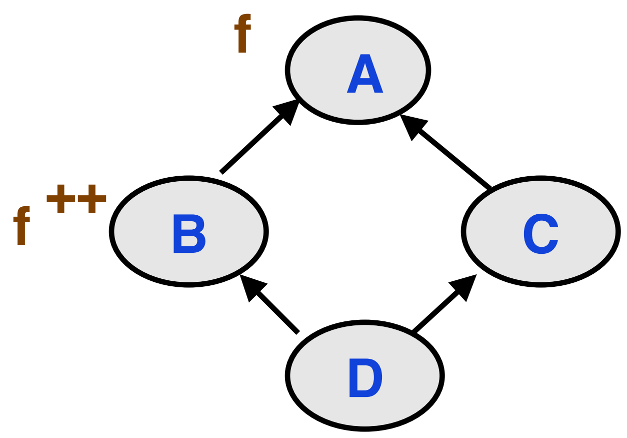
Conflict Resolution – Joining

- Different names
  - » **Have compatible signatures and semantics**
  - » **Join the solutions**



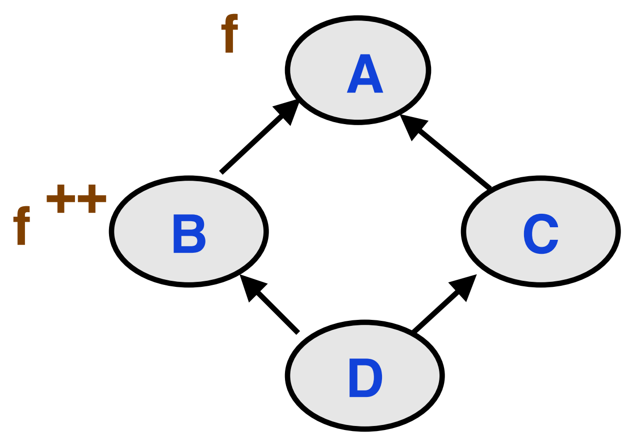
```
class D inherit
   B
   C rename g as f
      undefine f end
....
```

Conflicting Redefinition



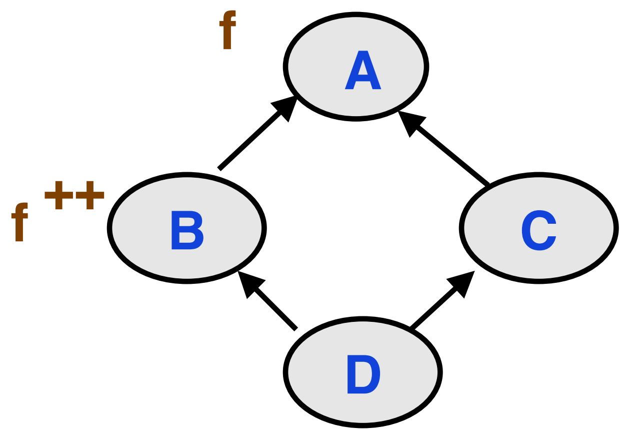
- In D have two different definitions of f
  - » From B and from A through C

Conflicting Redefinition – 2



- In **D** have two different definitions of **f**
  - » **From B and from A through C**
- Consider under
  - » **sharing**
  - » **replication**

Conflict Resolution – Sharing

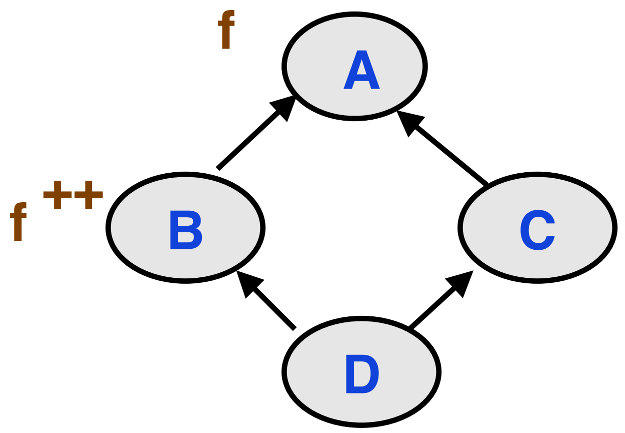


- Inherit under same name
  - » one version is deferred other is effective
    - > No problem – single name rule
  - » both versions effective but redefined in D
    - > No problem – produce one redefined version

» both effective, do not want redefinition

> Problem – name clash, must rename, get replication

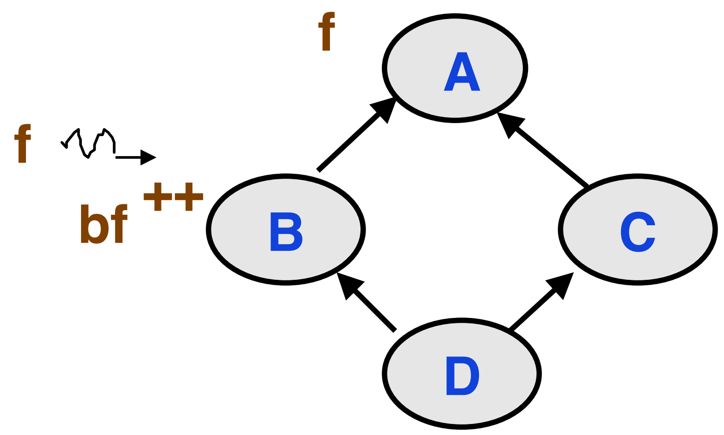
Conflict Resolution – Sharing – 2



- Another solution
  - » Make one of the versions deferred – Other takes over

```
class D inherit
    B
    C undefine f end
....
```

Conflict Resolution – Replication



- Suppose **a1** **:=** instance of **D**
  - » **Then a1.f is ambiguous**
    - > **could be either f or bf**
- Programmer must **select** the version

```
class D inherit
    B
    C select f end
....
```

```
class D inherit
    B select bf end
    C
....
```

Select Rule

A class that inherits two or more different effective versions of a feature from a repeated ancestor and does not redefine them both, must include exactly one of them in a select clause

- **Use select all if that is desired**

Genericity with Repeated Inheritance

The type of any feature that is shared under the repeated inheritance rule, and the type of any of its arguments if it is a routine, may not be a generic parameter of the class from which the feature is repeatedly inherited

```
class A[G]  feature
    f : G
end
```

```
class B inherit
    A [INTEGER]
    A [REAL]
end
```

» Ambiguity as to the type for f in B.

» If genericity is needed, use renaming to get replication

Name Clash Definition

- In a class obtained through multiple inheritance, a **name clash** occurs when two features inherited from different parents have the same final name

Name Clash Rule

A **name clash** makes the class **invalid** **except** in any of the following cases

- **The two features are inherited from a common ancestor and none has been redefined from the version in that ancestor**
- **Both features have compatible signatures and at least one of them is inherited in deferred form**
- **Both features have compatible signatures and they are both redefined in the class**

Summary of Adaptation Clauses

- Eiffel adaptation clauses are in the following order.

```
class B
    inherit A
      rename f1 as new_f1, f2 as new_f2, f3 as new_f3
      export {A, B} new_f1, f4
      undefine new_f3, f6
      redefine new_f2, f5
      select new_f2, f7
    end
```