CSc 553 — Principles of Compilation

17 : OO Languages — Multiple Inheritance

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Multiple Inheritance

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Multiple Inheritance

- In some languages (C++, Eiffel) a class can have more than one superclass.

```
class Person { Name : STRING; }
class Student extends Person {
   Advisor : Teacher;}
class Teacher extends Person {
   Salary : INTEGER;
   method Rich () : BOOLEAN;
      return Salary > 50000;}
class Tutor extends Student, Teacher {
   Boss : Teacher;}
```

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Multiple Inheritance...

```
class Teacher extends Person {
   Salary : INTEGER;
   method Rich () : BOOLEAN;
      return Salary > 50000;}
```

`Rich()` should translate into:

```
PROCEDURE Rich (
   SELF : Teacher) : BOOLEAN;
   RETURN SELF^.Salary > 50000;
```

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Multiple Inheritance...

- We'd like to be able to call `m.Rich()` for any `Teacher` object, including a `Tutor`:

```
PROCEDURE Rich (
   SELF : Teacher) :  BOOLEAN;
   RETURN SELF^.Salary > 50000;

Teacher Knuth = new Teacher;
Tutor Lucy = new Tutor;
boolean k = Knuth.Rich()
boolean l = Lucy.Rich()
```

- In order for this to work, the `Salary` field in a `Tutor` record must be at the same offset as the `Salary` field in the `Teacher` record.

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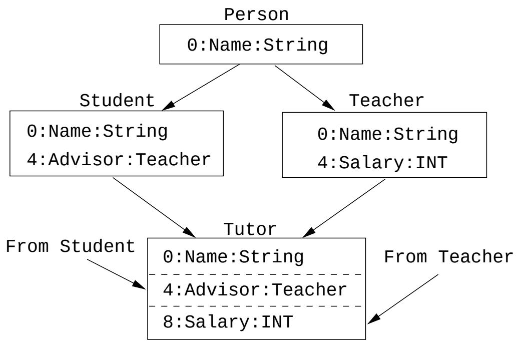
Multiple Inheritance...

- But, if our record layout uses simple concatenation of parent classes (like with single inheritance), we get:



- The `Salary` field in a `Teacher` record is at offset 4, but the `Salary` field in the `Tutor` record is at offset 8.

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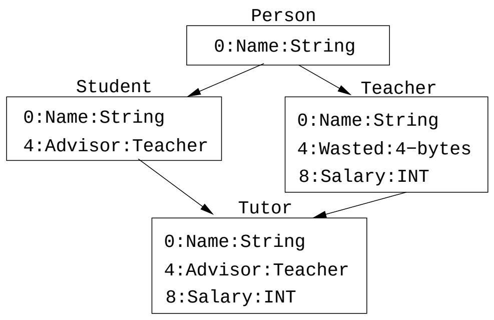
Multiple Inheritance...

- An inefficient implementation might do:

```
PROCEDURE Rich (SELF : Teacher) :  BOOLEAN;
   RETURN IF ISTYPE(SELF,Teacher)
      THEN (SELF-4)^>50000 ELSE (SELF+8)^>50000;
```

- Or we could insert extra space to align the fields properly:



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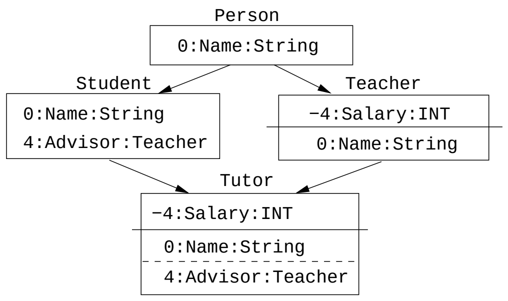
Multiple Inheritance…

- With *multi-directional* layouts, we place variables at both positive and negative offsets:



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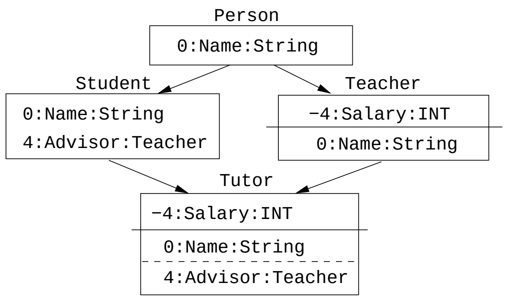

Multiple Inheritance…

- The `Salary`-field is always at the same offset, regardless of what type of object:

```
PROCEDURE Rich (
   SELF : Teacher) :  BOOLEAN;
   RETURN (SELF-4)^>50000;
```

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Multiple Inheritance…

- How does the language deal with the same field inherited through more than one path? A `Tutor` inherits `Name` twice, once from `Student` and once from `Teacher`:

```
class Person { Name :  STRING; }
class Student extends Person {···}
class Teacher extends Person {···}
class Tutor extends Student,Teacher {···}
```

- Should `Tutor` have one or two copies of `Name`?
- In Trellis/Owl you always get just one copy of `Name`.
- In C++ you can choose. If you declare a superclass *virtual*, `Tutor` only gets one copy of `Name`, otherwise two.

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Multiple Inheritance...

- How does the language deal with different fields/methods with the same type/signature inherited from different classes?

```
class Student {Name :  STRING; ··· }
class Teacher {Name :  STRING; ··· }
class Tutor extends Student,Teacher {···}
Tutor T = new Tutor();
T.Name = "Knuth"; /* Which Name?  */
```

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Multiple Inheritance...

```
class Student {Name :  STRING; ··· }
class Teacher {Name :  STRING; ··· }
class Tutor extends Student,Teacher {···}
Tutor T = new Tutor();
T.Name = "Knuth"; /* Which Name?  */
```

- In Eiffel, the programmer has to rename fields until there are no more conflicts, using a **rename** clause:

  ```
  class Tutor extends Student,
     Teacher rename Name⇒TName {···}
  ```

- In C++, conflicts are resolved when the field/method is used:

  ```
  Tutor T = new Tutor();
  Teacher::T.Name = "Knuth";
  ```

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Readings and References

- Read Scott: 146-CD-157-CD.
- For information on constructing layouts for multiple inheritance, see
  - William Pugh and Grant Weddell: "Two-directional record layout for multiple inheritance."