CMPT 373
Software Development Methods

Using Inheritance (and Not Abusing It)

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with some material from Bertrand Meyer

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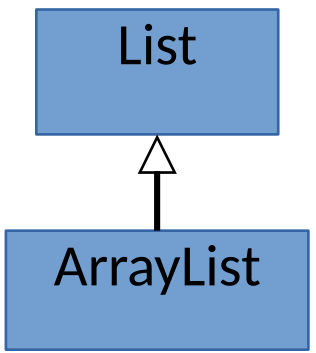

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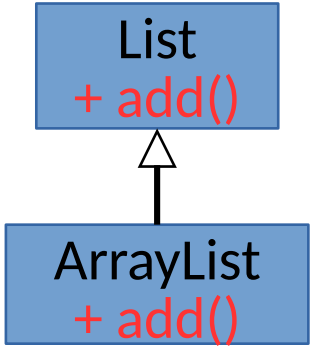

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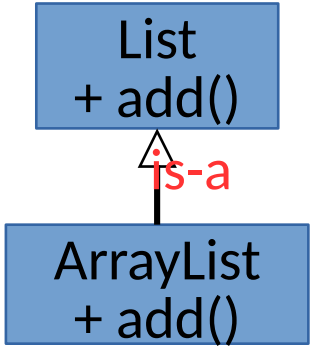

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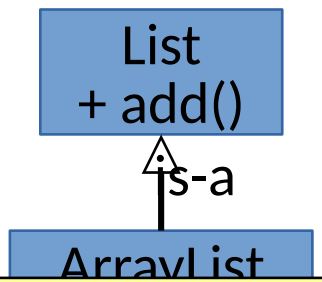

Note: This conflates ***inheritance*** & ***subtyping***,
but it is probably what you know (from Java/C++).

What does good inheritance look like? (Review)_____

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Derived is ***substitutable*** for Base

Base
A foo(B b)

Derived
C foo(D d)

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B <: D

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Arguments are ***contravariant***

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C <: A

Base	Derived
A foo(B b)	C foo(D d)

Return types are ***covariant***

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    - Preconditions are not stronger

```
assert(x > 0)
```

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A foo(B b)

```
assert(x != 0)
```

Derived
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`assert(result != 0)`	`assert(result > 0)`

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How does the Liskov Substitution Principle relate to coupling from using inheritance?

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class Parent {
  virtual void foo() { bar(); }
  virtual void bar() {}
};
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[Bloch, “Effective Java”]

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class Child : public Parent {
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class Parent { public:
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Non Virtual Interfaces (NVI) help clarify & are common in C++.

[Bloch, "Effective Java"]

```
class Parent {
public:
  void foo() { barImpl(); }
  void bar() { barImpl(); }
private:
  virtual void barImpl() = 0;
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};class Child : public Parent {
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Other patterns help even more...

[Bloch, "Effective Java"]

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Here endeth the review

So let’s try it out…

Note: We will go from absurd to practical

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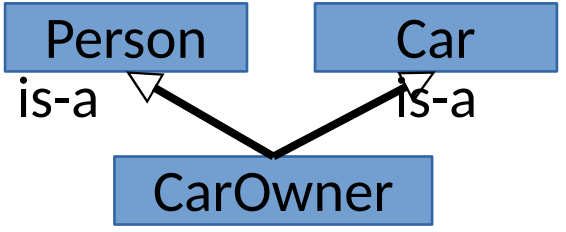

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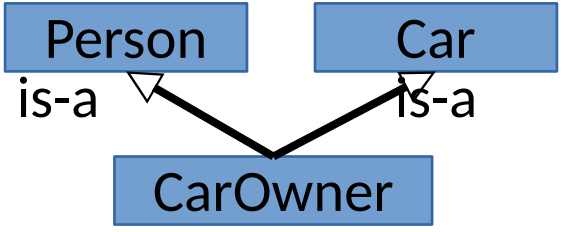


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class CarOwner : public Person, Car
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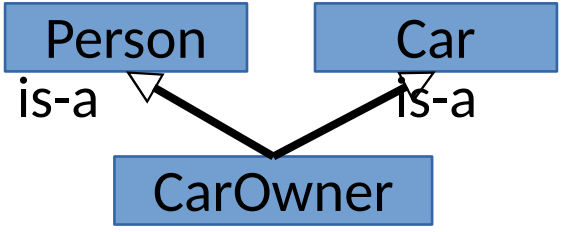


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Is this good or bad?
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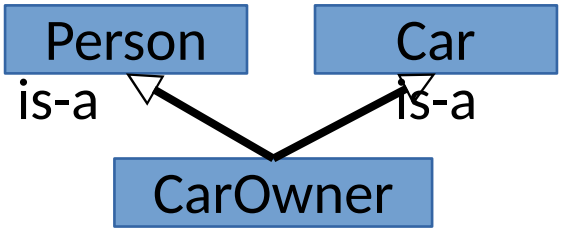


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How could you make it better?

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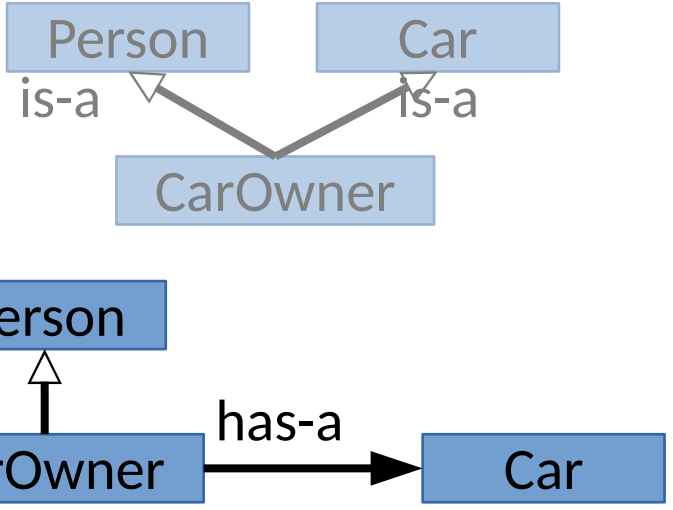

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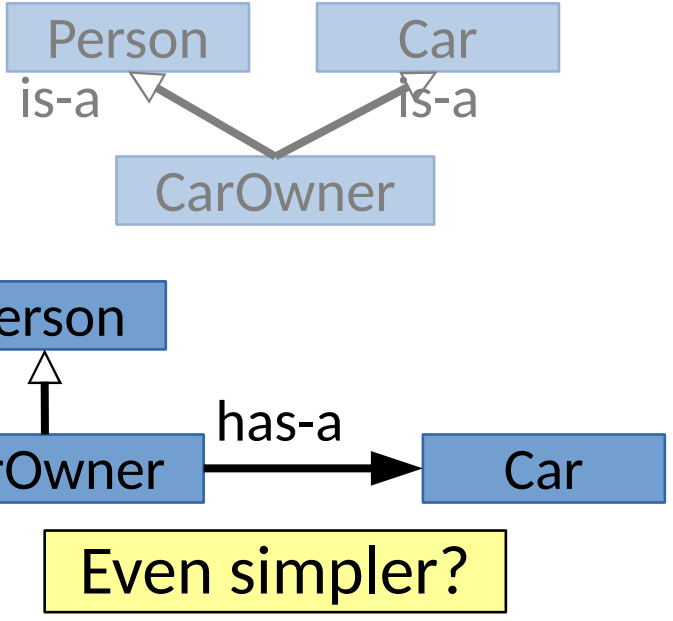

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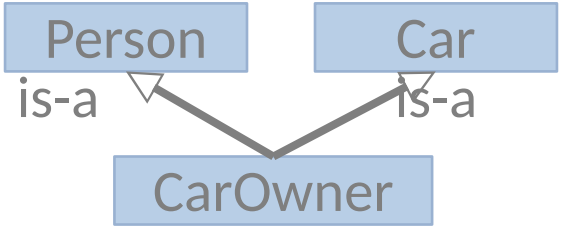

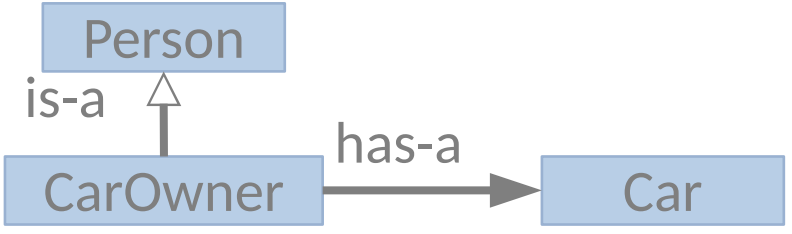

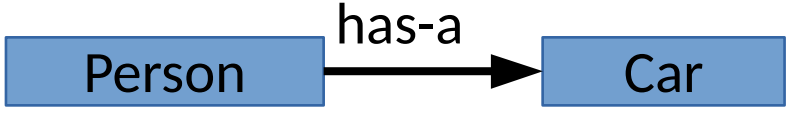

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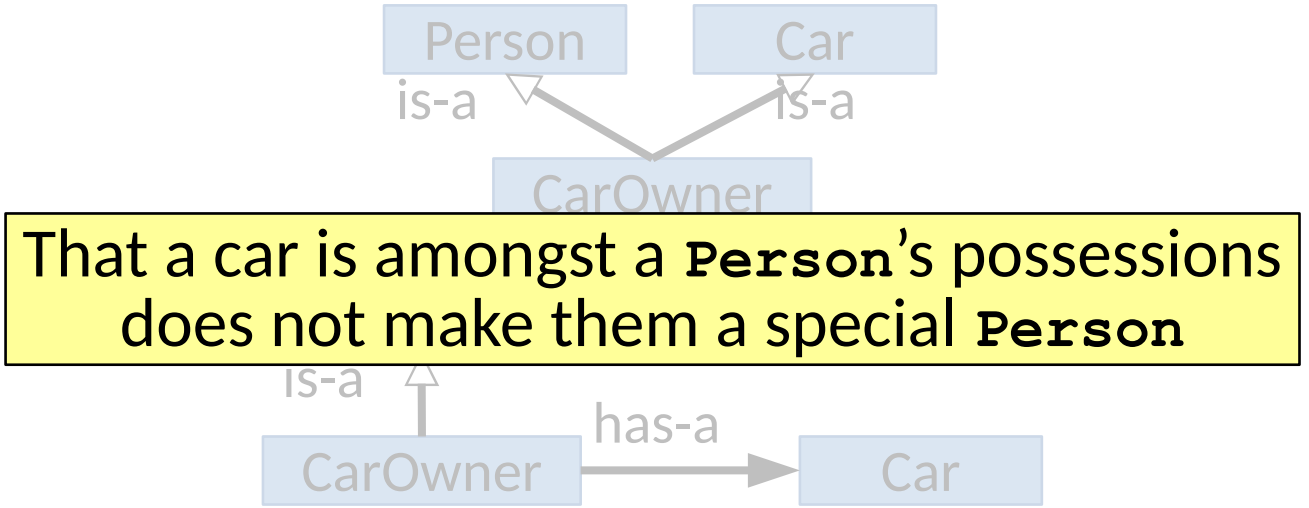

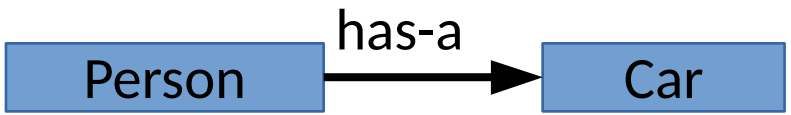

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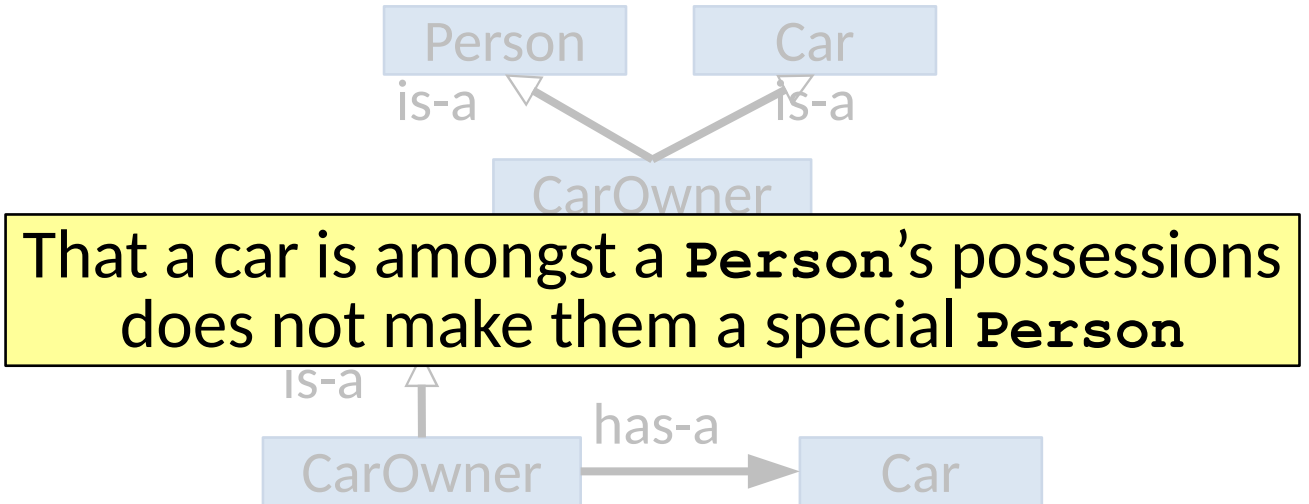

This absurd example captures common, subtle mistakes

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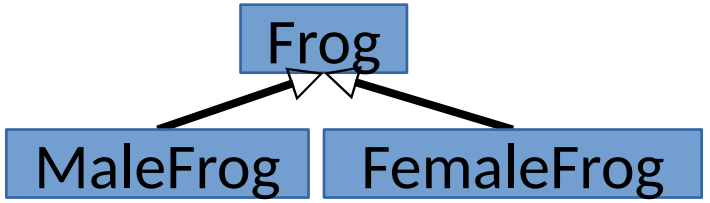

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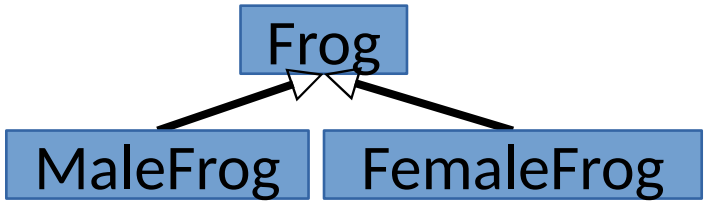

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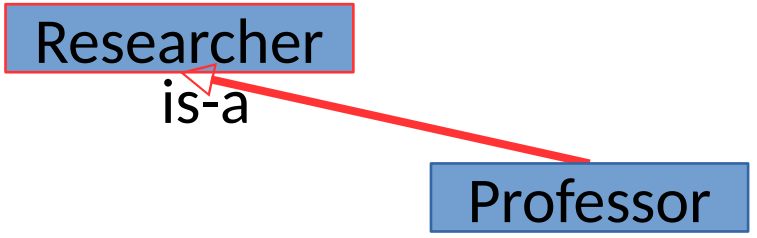

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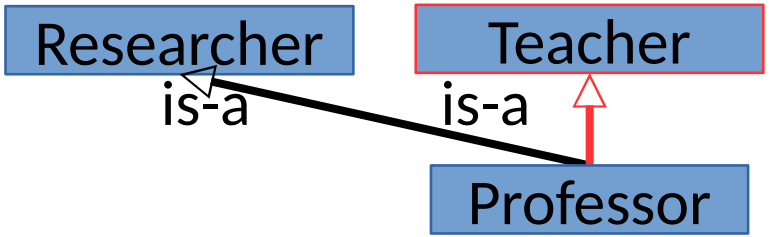

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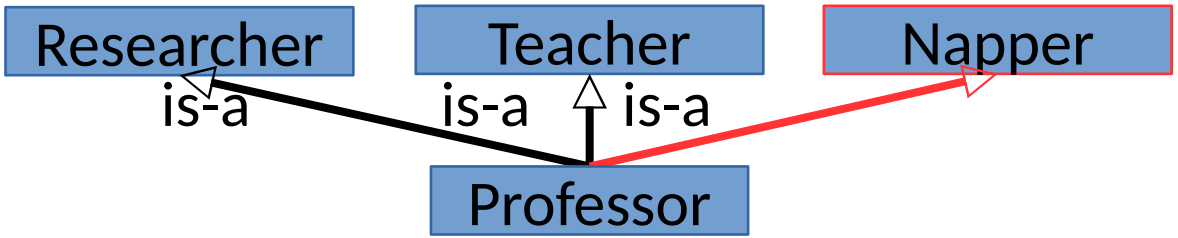

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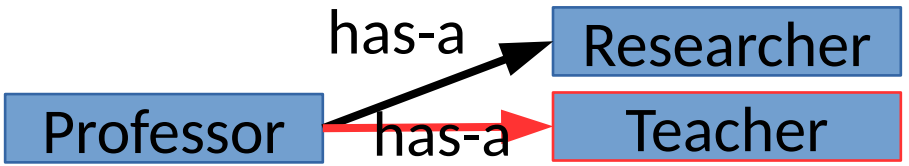

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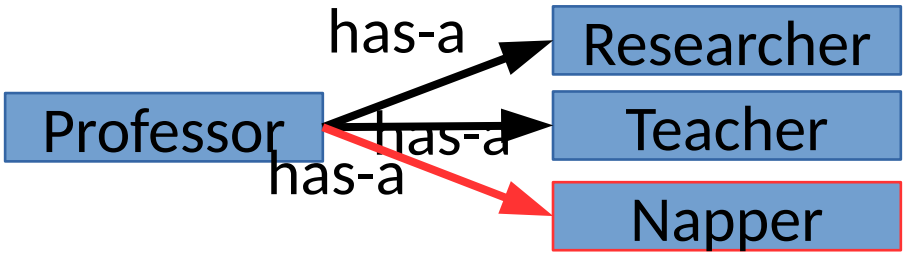

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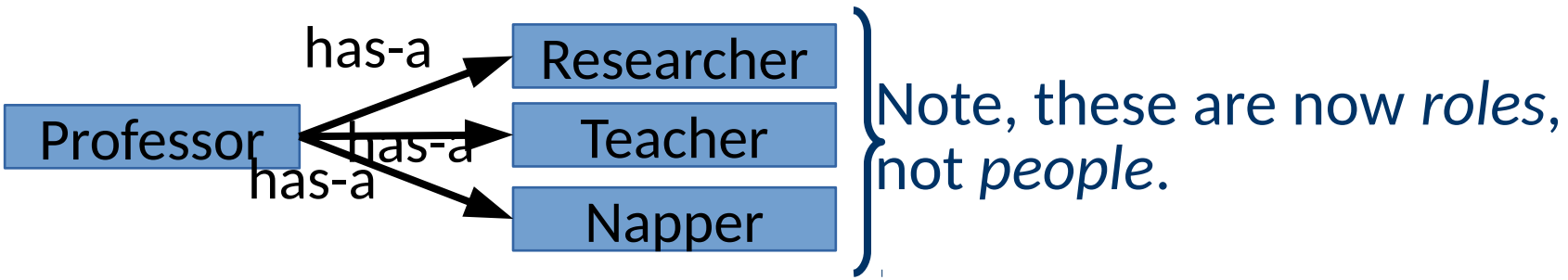

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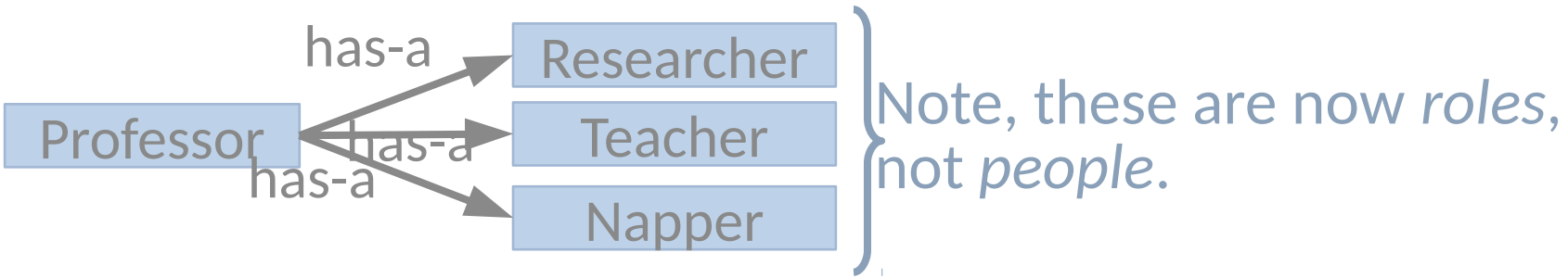

- **Whenever *is-a* applies, you must still make a decision**

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- Guide 1: Might the behavior need to change?
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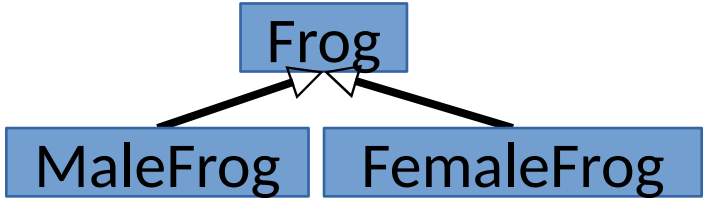

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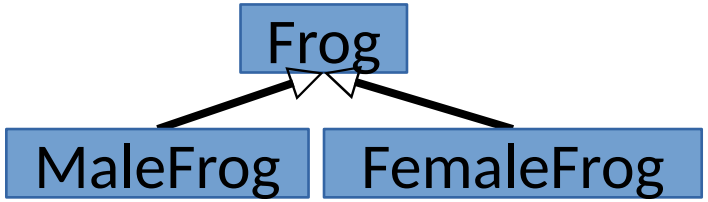

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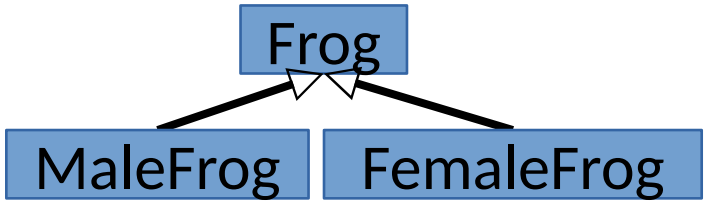

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Knowing in advance is hard.
Composition is flexible & adapts to requirements.

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  - Inheritance enables it
  - Consider inheritance when a reference to a general type may point to a more specific one.

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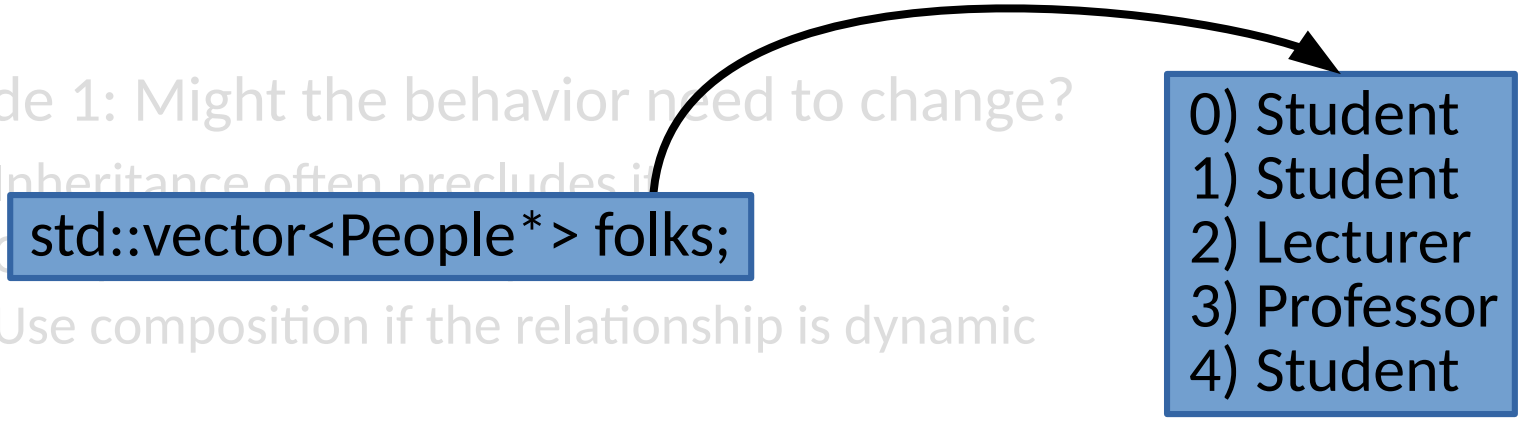

- Guide 2: Might the type be used polymorphically?
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Choosing is-a or has-a

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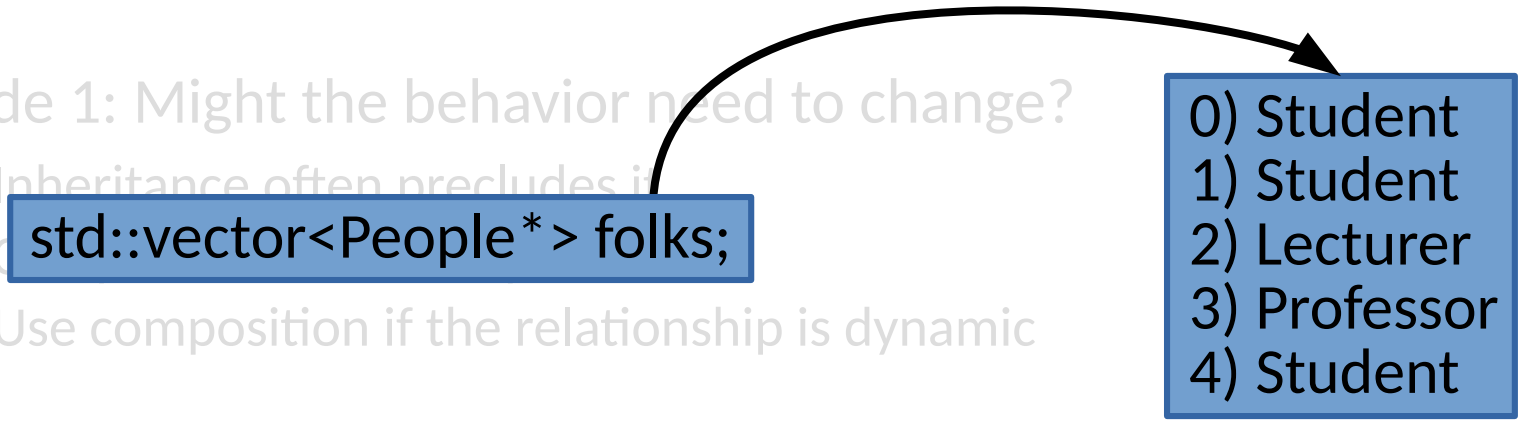

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We will revisit this in the context of ***algebraic data types***.

So let's try it out…

- I need
  - Many different types of animals.

This should sound familiar…

So let's try it out...

- I need
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What does my design look like based on the rules?

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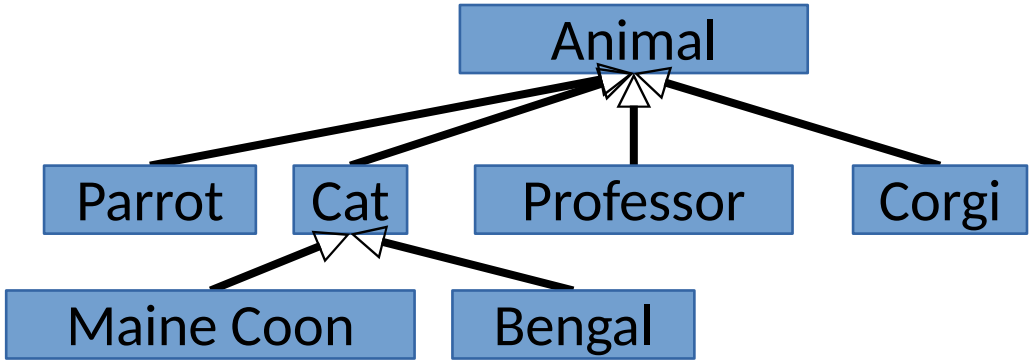

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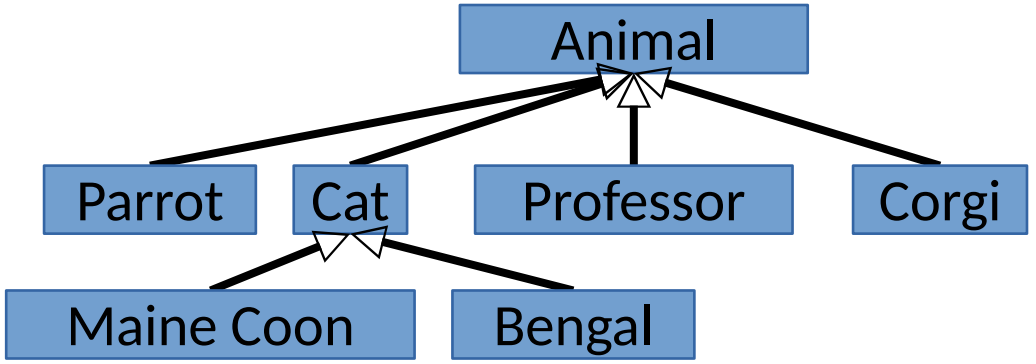

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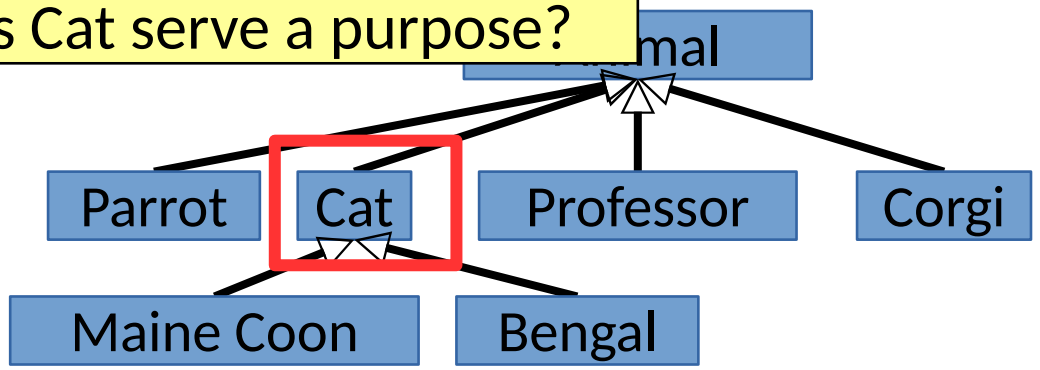
Does Cat serve a purpose?



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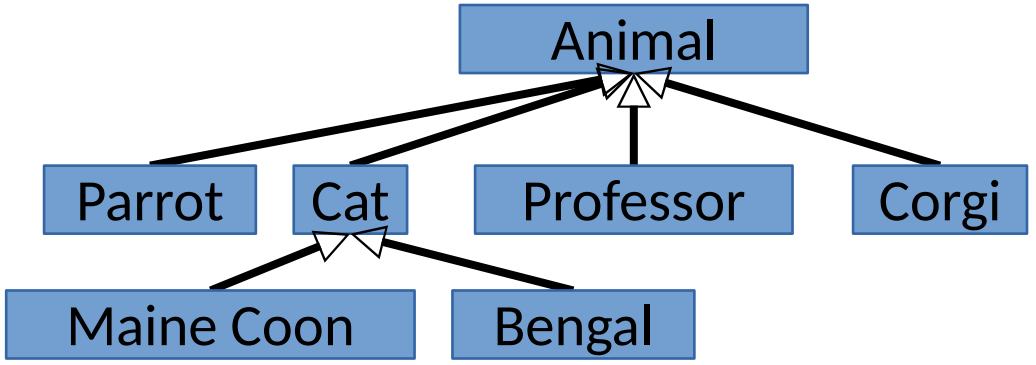

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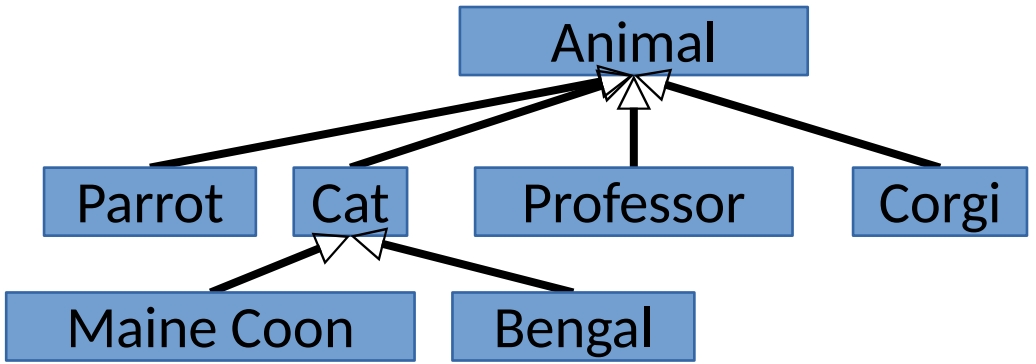

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What if I want a new Animal at run time?

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If someone on my team did this multiple times,
I would fire them.

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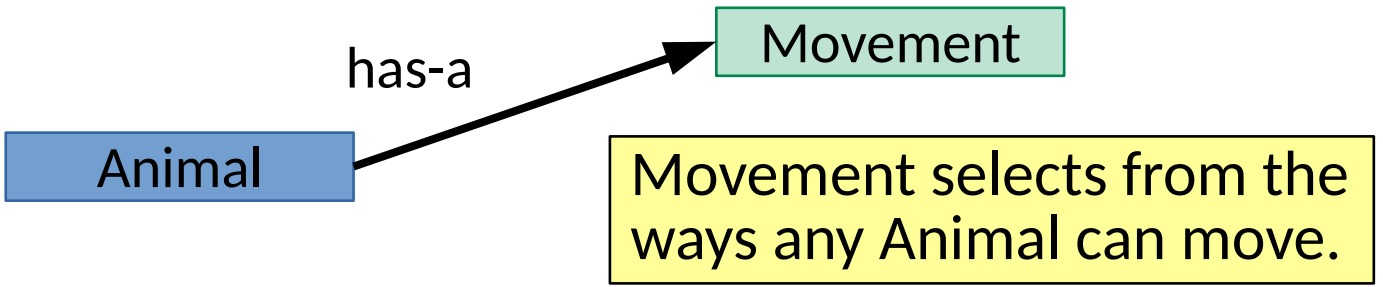

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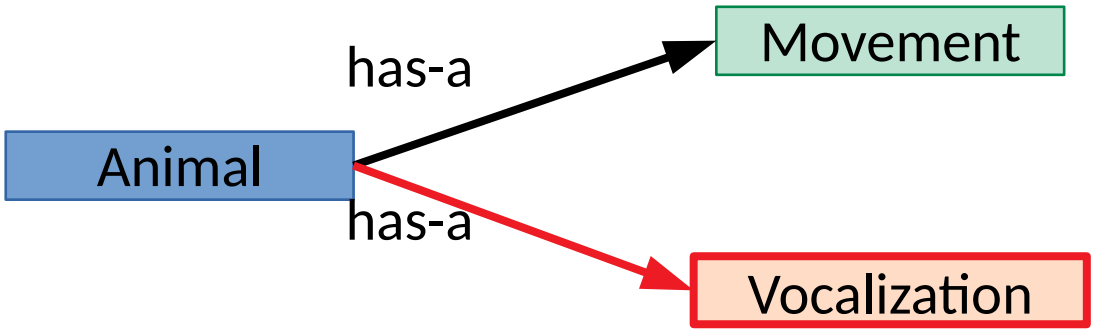

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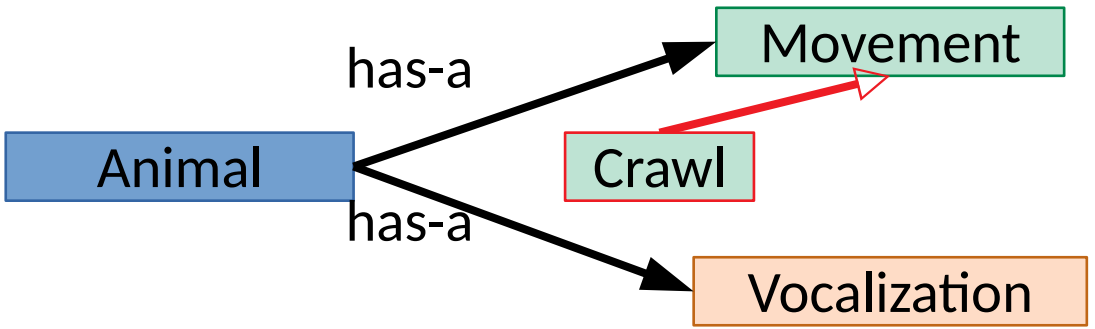

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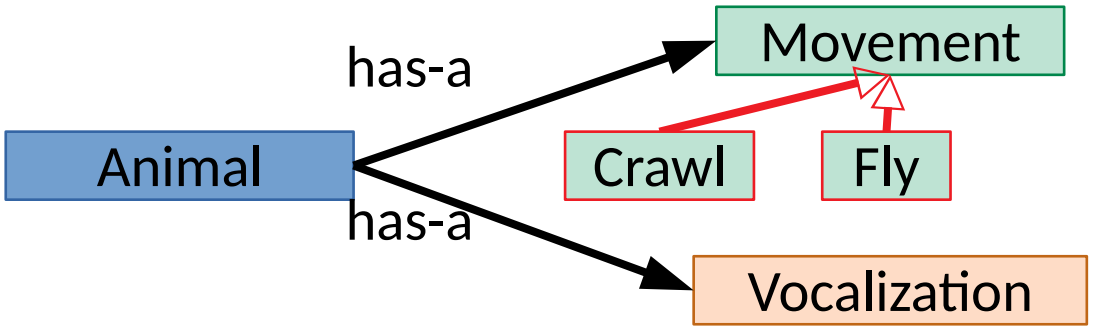

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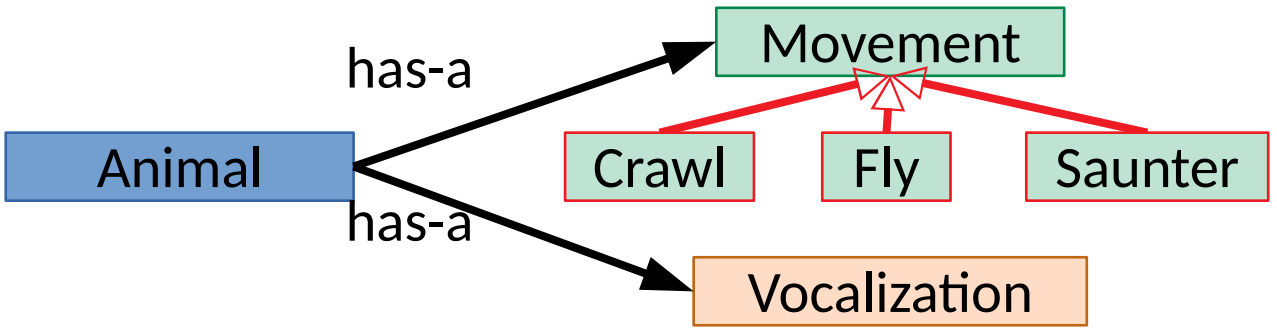

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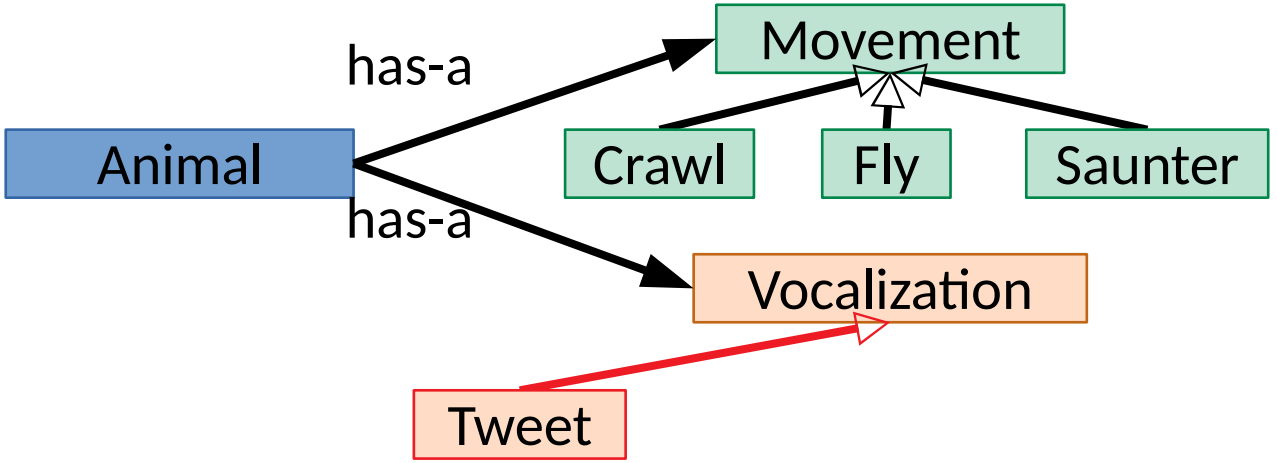

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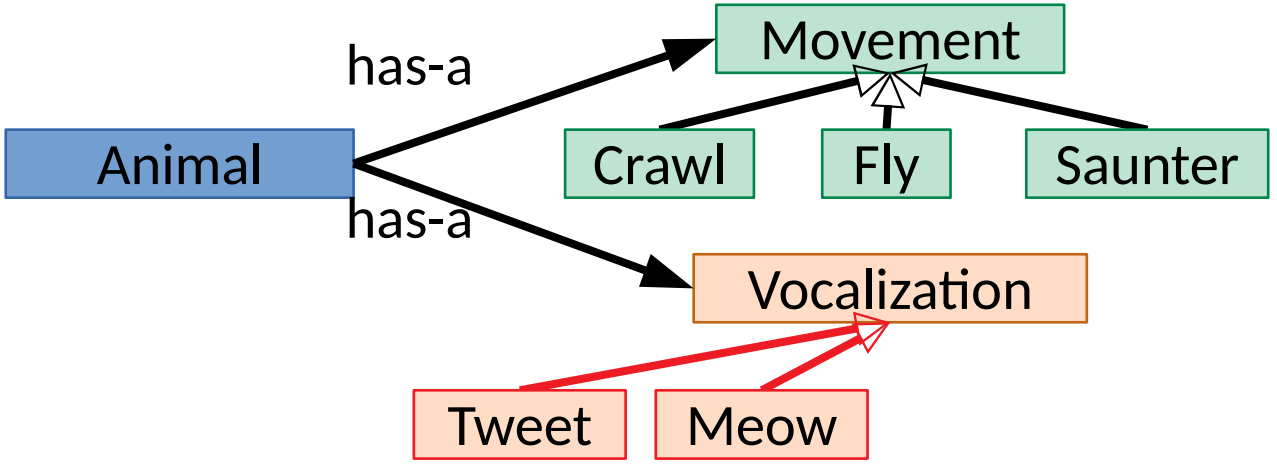

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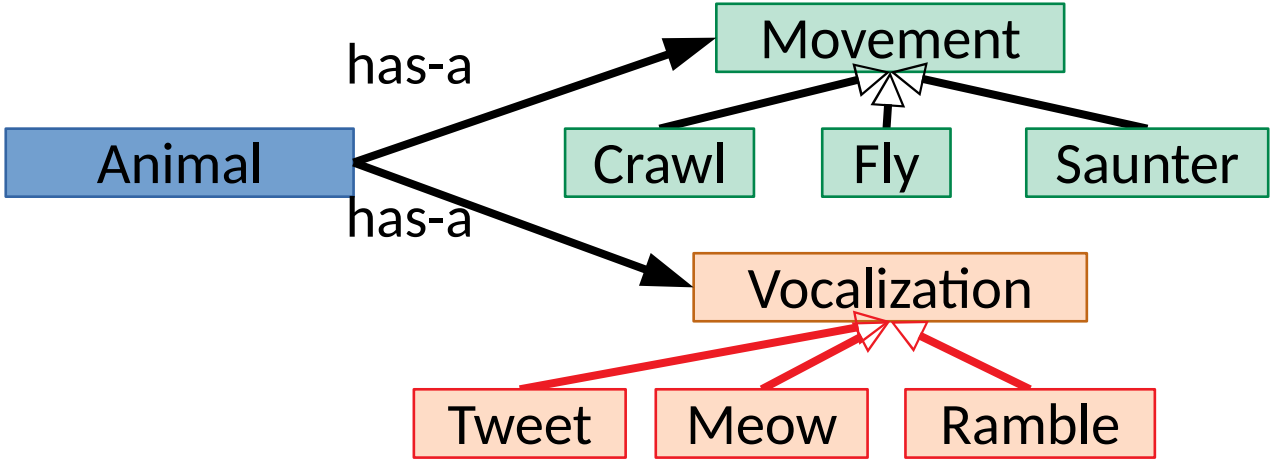

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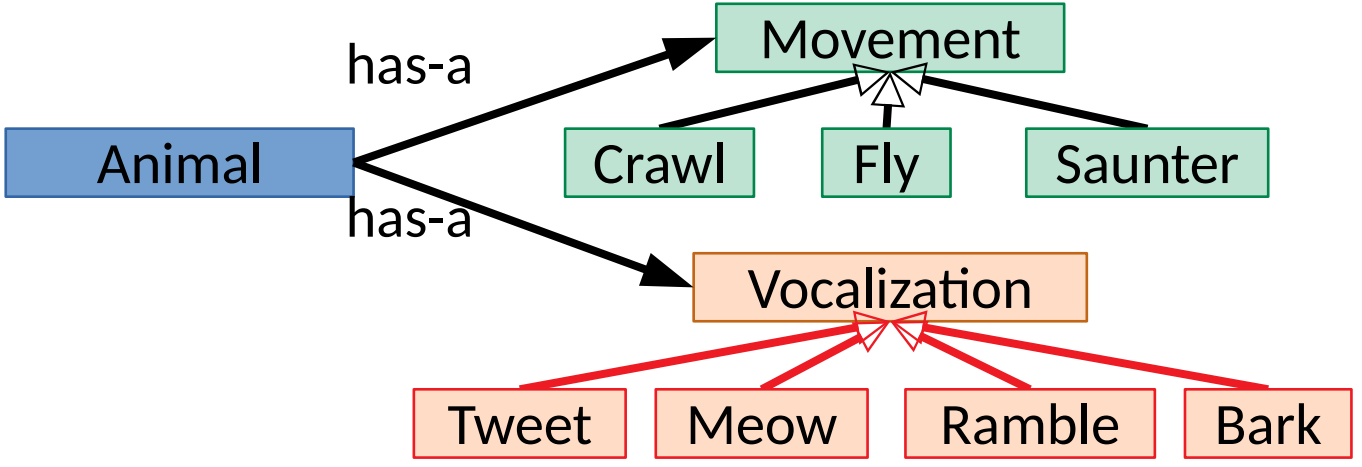

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class Animal {
  Movement& m;
  void move() {
    m.move();
  }
};
```

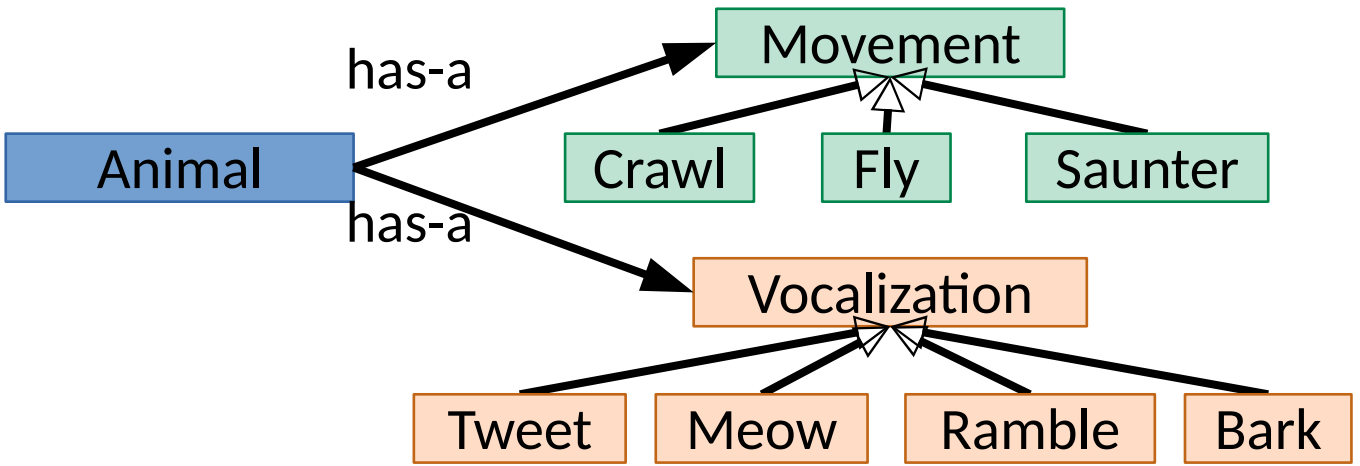

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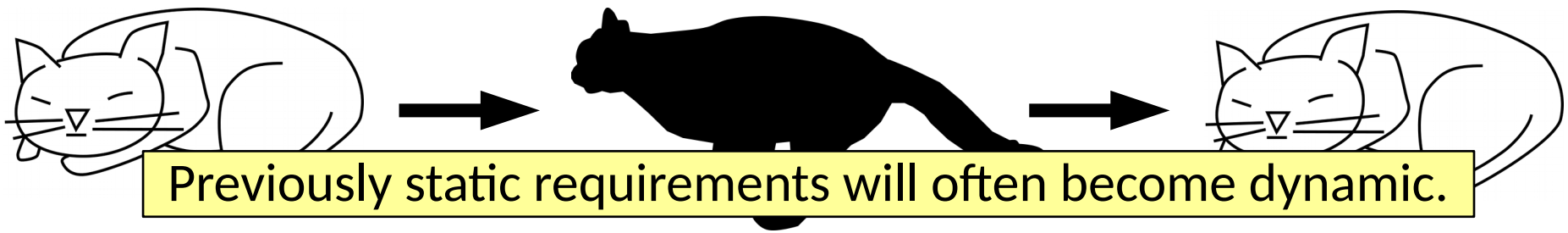

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- Directly identifies & addresses risks of change in class design
- We will see shortly how this interacts with other forms of polymorphism

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- Good inheritance simplifies design & both expresses and isolates regions of change
- There is no best design. Be pragmatic, but smart.