Introduction to Inheritance

Lecture 23
Sections 11.9, 11.10

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1. Inheritance
2. The HAS-A Relation
3. The IS-A Relation
4. Assignment

Outline

1. Inheritance
2. The HAS-A Relation
3. The IS-A Relation
4. Assignment

Object-Oriented Programming

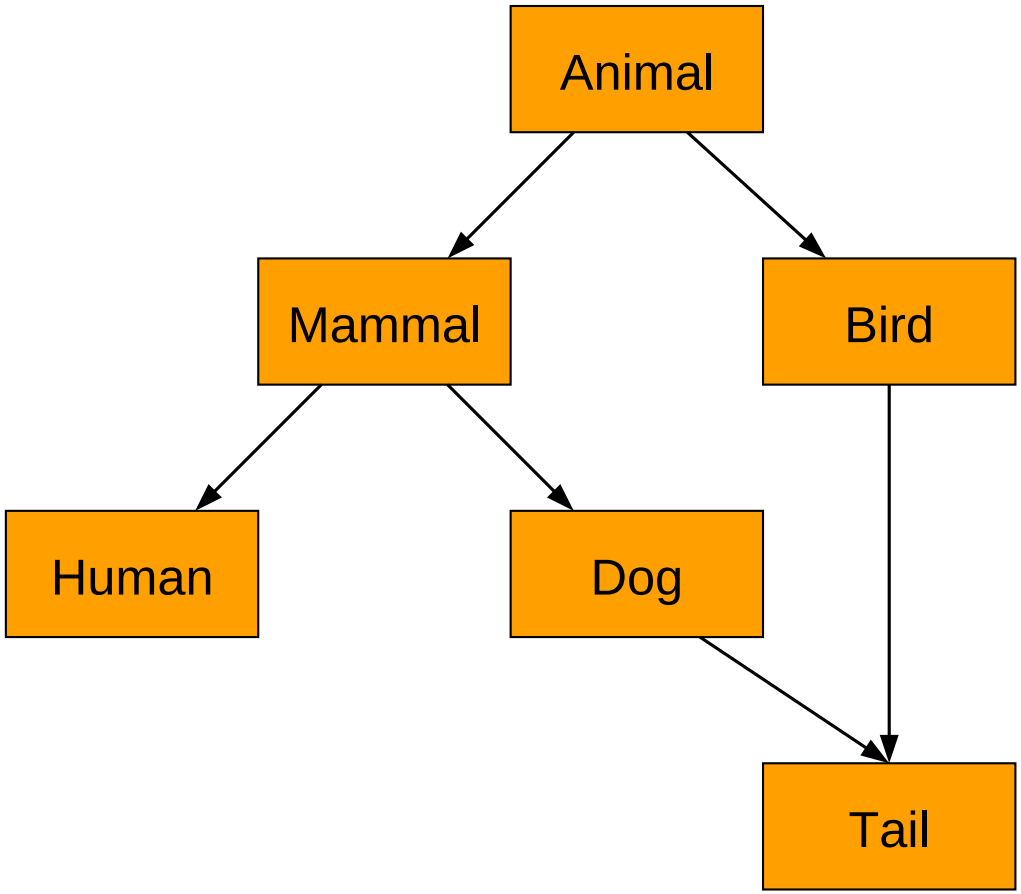
- The basic principle of object-oriented programming is to create objects and relationships between them that reflect reality.
- This should make the programming more intuitive.
- But it does take effort.

Example

Example (Relationships)

- What are the relationships among the following types of object?
  - human
  - mammal
  - dog
  - bird
  - animal
  - tail

Hierarchy of Objects



Inheritance in C++

- In C++ a new class may be derived from an existing class.
- The new class is called the derived class or the subclass.
- The original class is called the base class or the superclass.

Inheritance in C++

- The subclass inherits all the data members and member functions of the base class.
- The subclass also has its own data members and member functions.
- Furthermore, the subclass may redefine inherited functions.

Example

- We could derive the `Mammal` class from the `Animal` class.
- Does a mammal have all the attributes of animals in general?

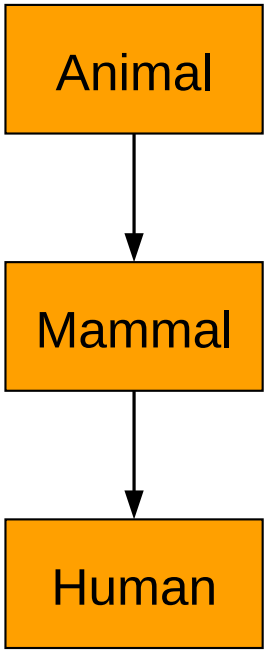
Example

- We could derive the `Human` class from the `Mammal` class.
- Does a human have all the attributes of mammals in general?

Example

- Should we derive the `Tail` class from the `Dog` class?
- Does a tail have all the attributes of dogs in general?

General Guidelines



Generally speaking, the hierarchy should go from the most general class at the top down to the most specific class at the bottom.

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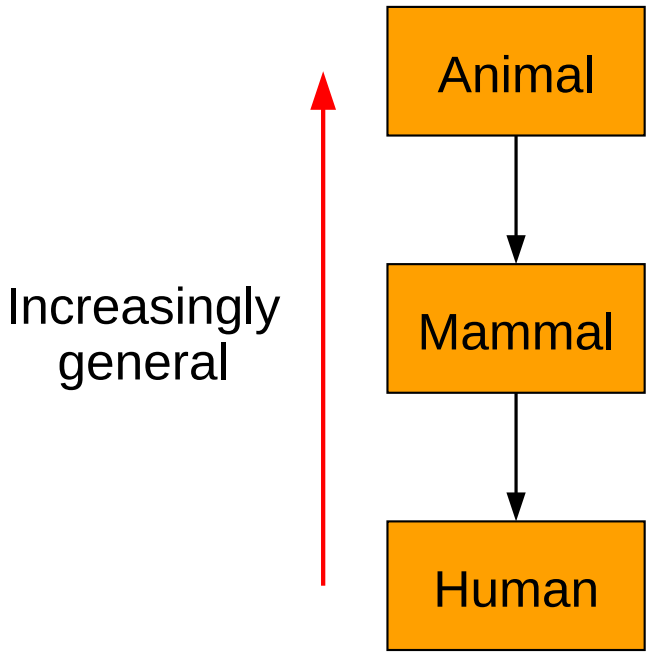

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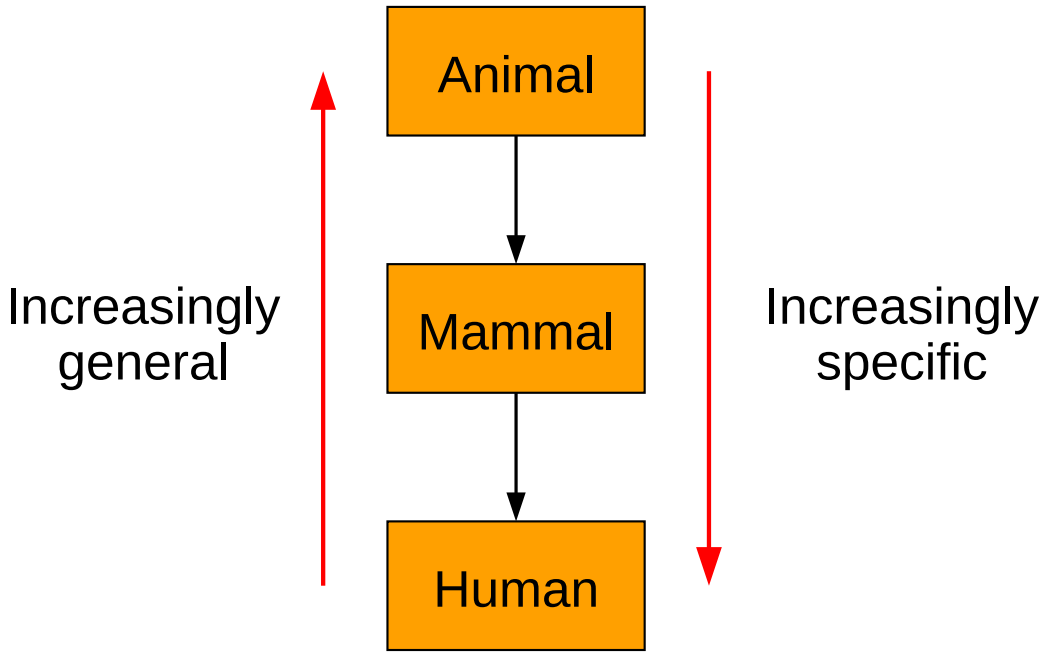

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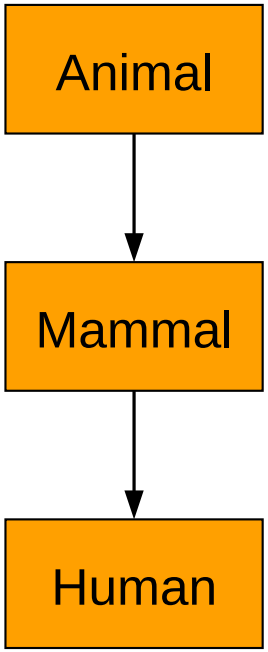

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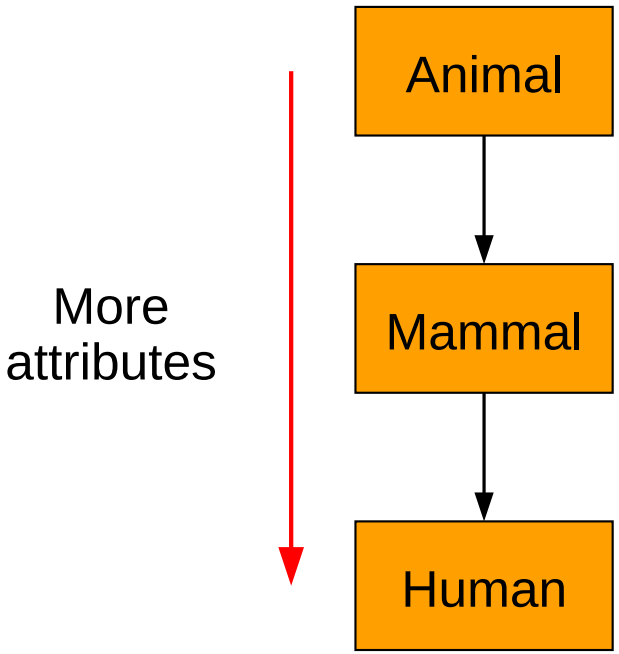

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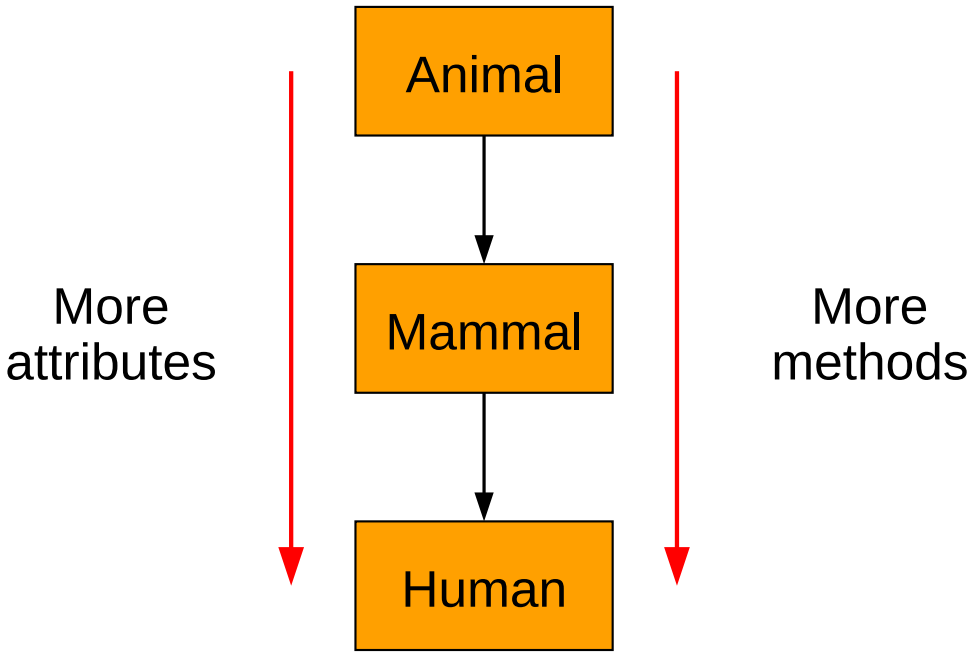

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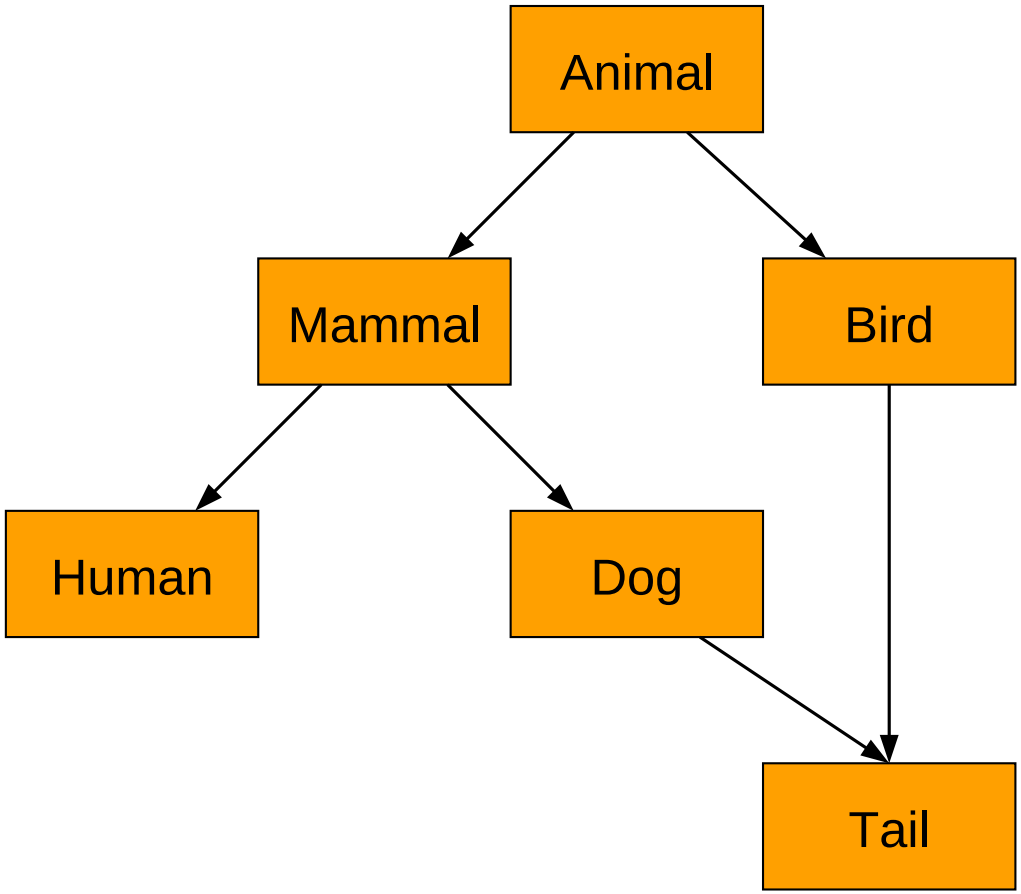
Design Decisions

- It is not always easy to decide when to derive one class from another.
- The decision should reflect the way we think about the classes.
- Two helpful relations
  - IS-A
  - HAS-A

Hierarchy of Objects



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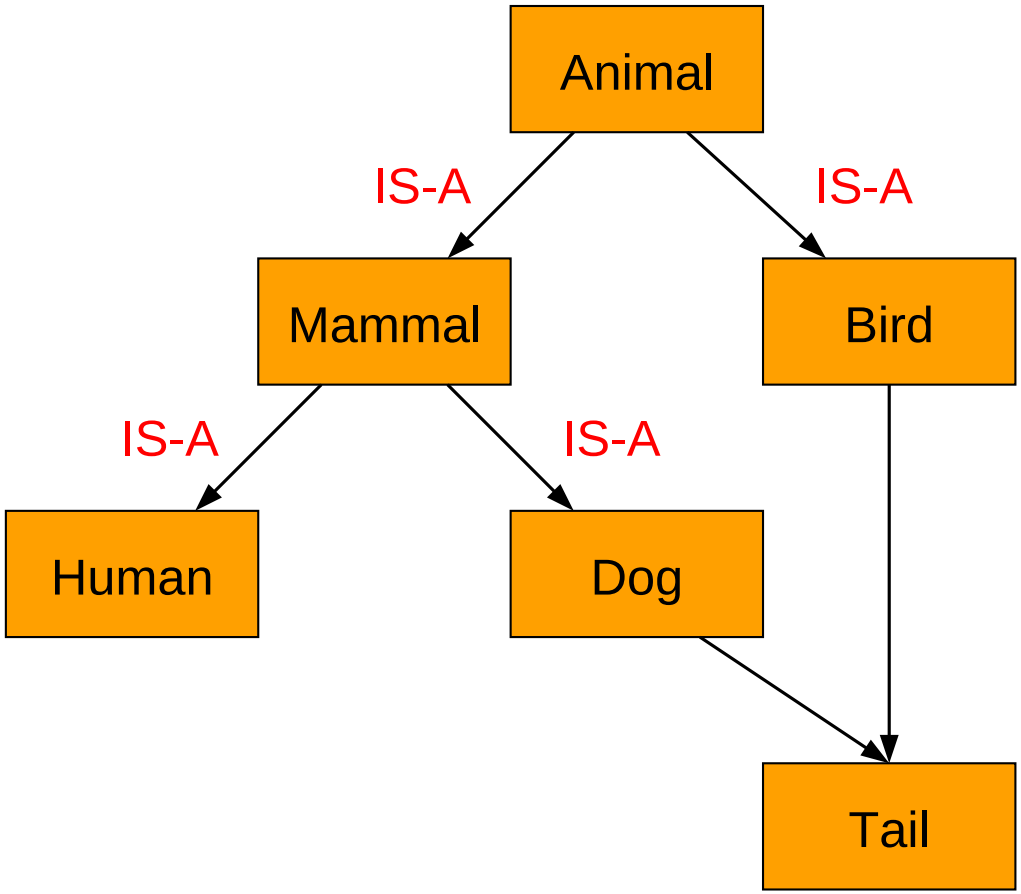

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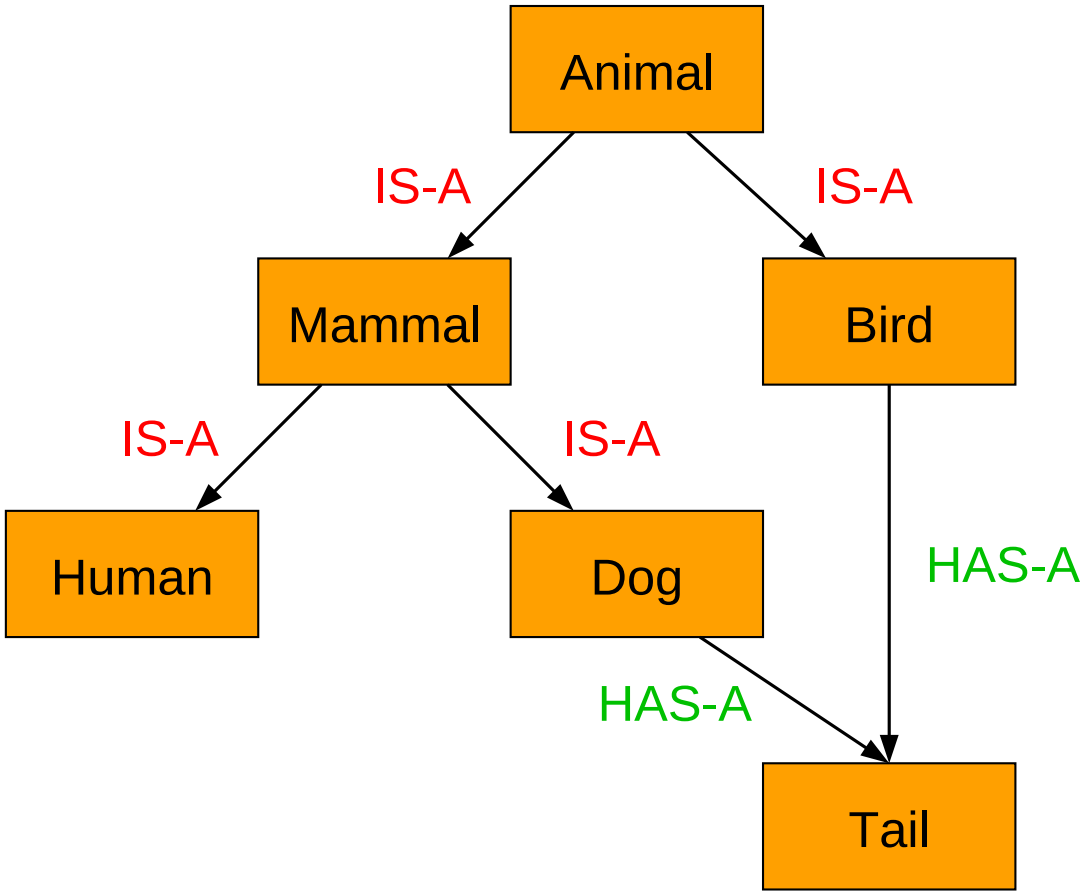

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The HAS-A Relation

- If an object of class A HAS a component that is an object of class B, then the HAS-A relation holds from class A to class B.
- If every class A object HAS-A class B component, then an object of class B should be a data member of class A.

Example

Example (HAS-A Relation)

- A `Car` has an `Engine`.
- A `Car` has `Wheel`s.
- The HAS-A relation holds from classes `Engine` and `Wheel` to class `Car`.

Example

Example (HAS-A Relation)

```
class Engine;
class Wheel;
class Car
{
//  Data members
    Engine e;
    Wheel w[4];
};
```

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The IS-A Relation

- If an object of class A IS an object of a more general class B, then the IS-A relation holds from class A to class B.
- If every class A object IS-A class B object, then class A should be a derived class of class B.

Example

Example (IS-A Relation)

- A `Car` is a `MotorVehicle`.
- A `MotorVehicle` is a `Vehicle`.
- The IS-A relation holds from class `Car` to class `MotorVehicle` and from `MotorVehicle` to `Vehicle`.

Example

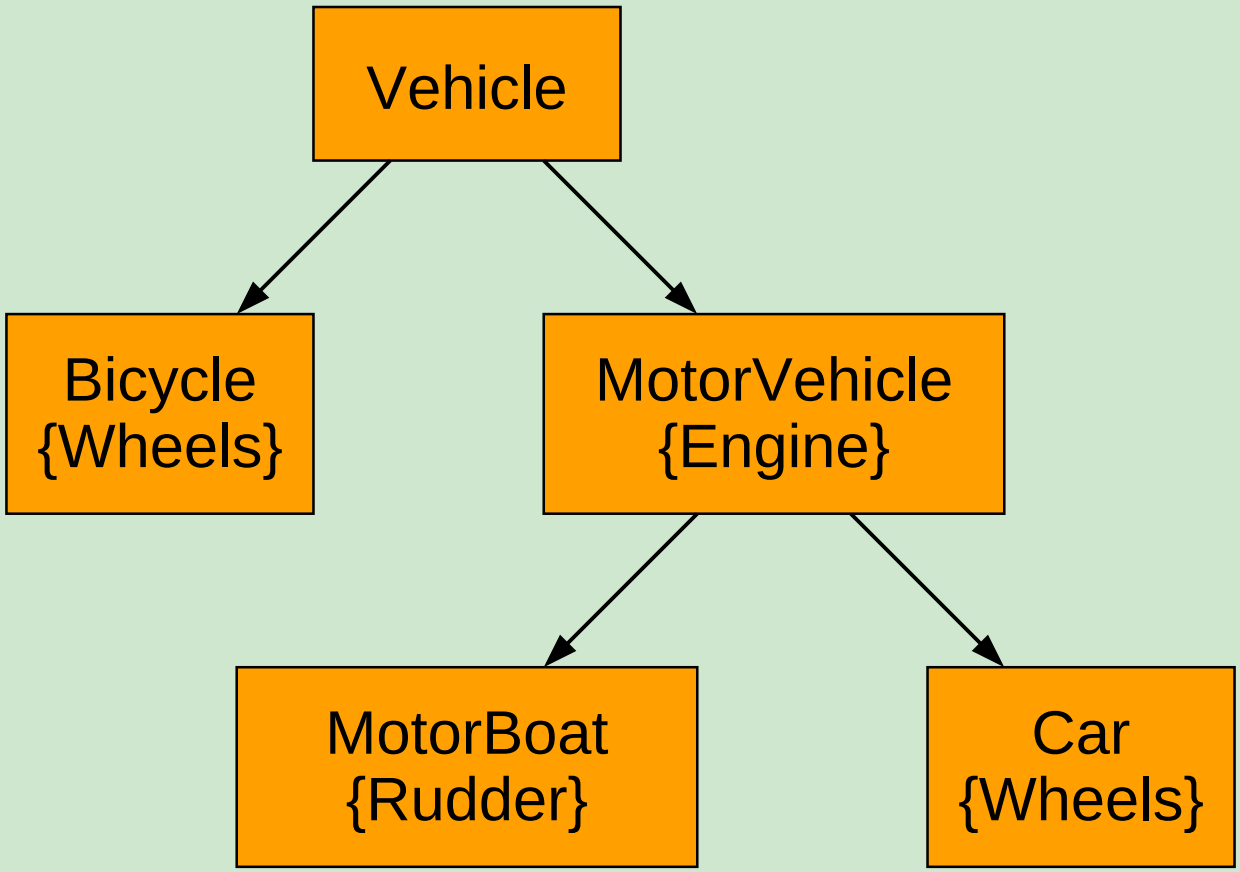
Example (IS-A Relation)

```
class Vehicle;
class MotorVehicle : public Vehicle
{
    Engine e;
};
class Car : public MotorVehicle;
{
    Wheel w[4];
};
class Boat : public Vehicle;
{
    Rudder r;
};
```

- Where would a `Motorboat` class fit in the hierarchy?

Example

Example (IS-A Relation)



Example

- Arrange the following classes in natural hierarchies.
  - `List`
  - `ArrayList`
  - `LinkedList`
  - `LinkedListNode`
  - `LinkedListwTail`
  - `DoublyLinkedList`
  - `DoublyLinkedListNode`
  - `CircLinkedList`

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- Read Sections 11.9, 11.10.