Polymorphism

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Recall

- When you create an instance of a derived class, it is both:
  - an instance of the base class
  - an instance of the derived class.

- So all of the actions/attributes possible with the parent class are possible with the derived class.

Speak!

Same command!

Results differ based on the type of animal.

Polymorphism Basic

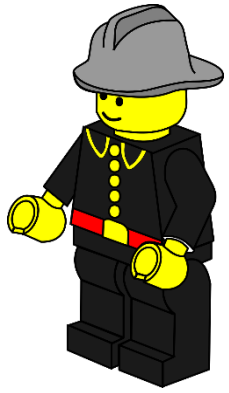
- A little Greek
  - What does poly mean?
  - What does morph mean?

- So when the person says “Speak”, each animal (morph / shape) speaks according to what type of animal it is.

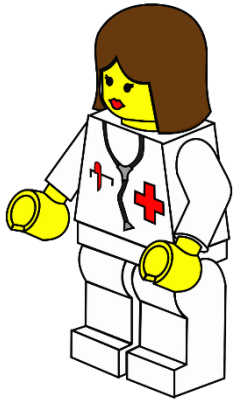
- With polymorphism, we can indicate a method (e.g. speak) and regardless of the underlying type, it will do what is appropriate for that type (e.g. “quack”, “meow”, “woof”).

Person Example

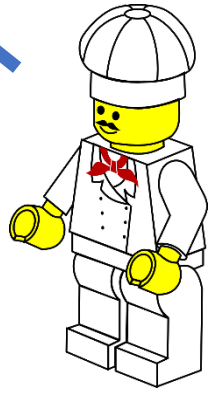
Person
(parent / base class)



Firefighter
(child / derived class)



Doctor
(child / derived class)



Chef
(child / derived class)

C++

- Can only see an object as one thing at a time.
  - E.g. can only treat an object as a person or as a firefighter depending on the current view (datatype... more in anatomy)

- Suppose you create a method/attribute in a derived class that exactly matches something in the parent (note: this is allowed)
  - If looking through firefighter lens, the firefighter version is used.
  - If looking through person lens, the person version is used.

Simple Interface

- We only need to know one method to use with an unknown number of sub-classes.

- So, with polymorphism, we can use the person lens to look at people and we do not have to worry about what sub-class each one is.

- However, not very useful if we can only do what the parent class does by default.

Polymorphism Useful

- What if we want to use the sub-class version instead of the parent-class version?
  - E.g. the firefighter version instead of the person version

- There needs to be a way to indicate that the sub-class version should ***override*** the parent version.

Virtual

- Indicate in the parent that the child version should be used instead if parent version is also available.
  - In C++ this is known as a virtual function.

- When looking at an instance of a base class, when it sees “virtual” it knows to use the derived class version of the function.
- If the derived class does not have its own version, it will use the base class version.

Abstract Class

- Suppose there is not a meaningful version to use in the base class?
  - Waiter: What you like for dinner, Sir?
    Customer: I'd like an appetizer, an entrée, and a dessert.
- Indicate that the method is abstract.
  - In C++ this is called a pure virtual function.
- When looking at an instance of a base class, when it sees "pure virtual" it knows it looks for the derived version.
- If the derived class does not have its own version, it will not compile.

Abstract Class

- An abstract class cannot be instantiated!

- In C++ this is accomplished by having at least one pure virtual function in the base class
  - While you probably shouldn't do this, you can also accomplish this by making the constructor(s) of the base class have protected visibility
- This makes sense.
  - If you have a pure virtual function, there is no default definition for that function, so it cannot be created.
- Child classes that will be instantiated MUST define its version of the pure virtual function.

Guidelines

- Want derived classes to have the **option** of overriding a function since a default is provided.
  - Make it a virtual

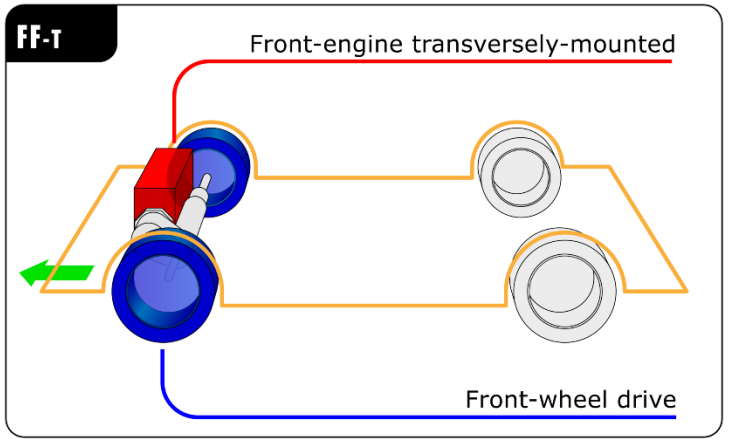
- Want to force derived classes to override a function (i.e. do not provide a default)
  - Make it pure virtual

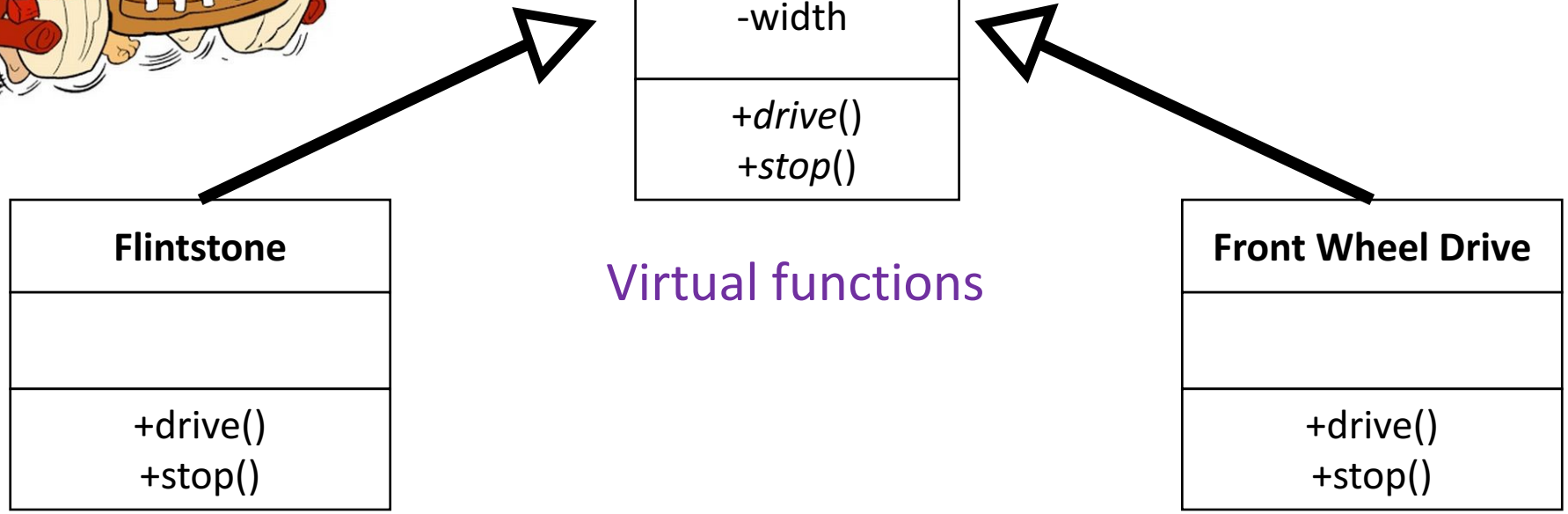
UML Update for Virtual

- UML supports indicating polymorphism
  by indicating virtual functions.
  - Virtual functions are written in italics. If hand written, underline.

- There is not a way to indicate pure virtual functions in standard UML.
  - On exams I will ask you to put "pv" before functions that should be pure virtual.

Different ways to drive.





Virtual functions

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