

LEC 02

CSE 123

Abstract Classes

Questions during Class?

Raise hand or send here

sli.do #cse123A

BEFORE WE START

*Talk to your neighbors:
Coffee or tea? Or something else?*

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Niyati	Trien	Lawrence	Evan	Cady
Ziao				

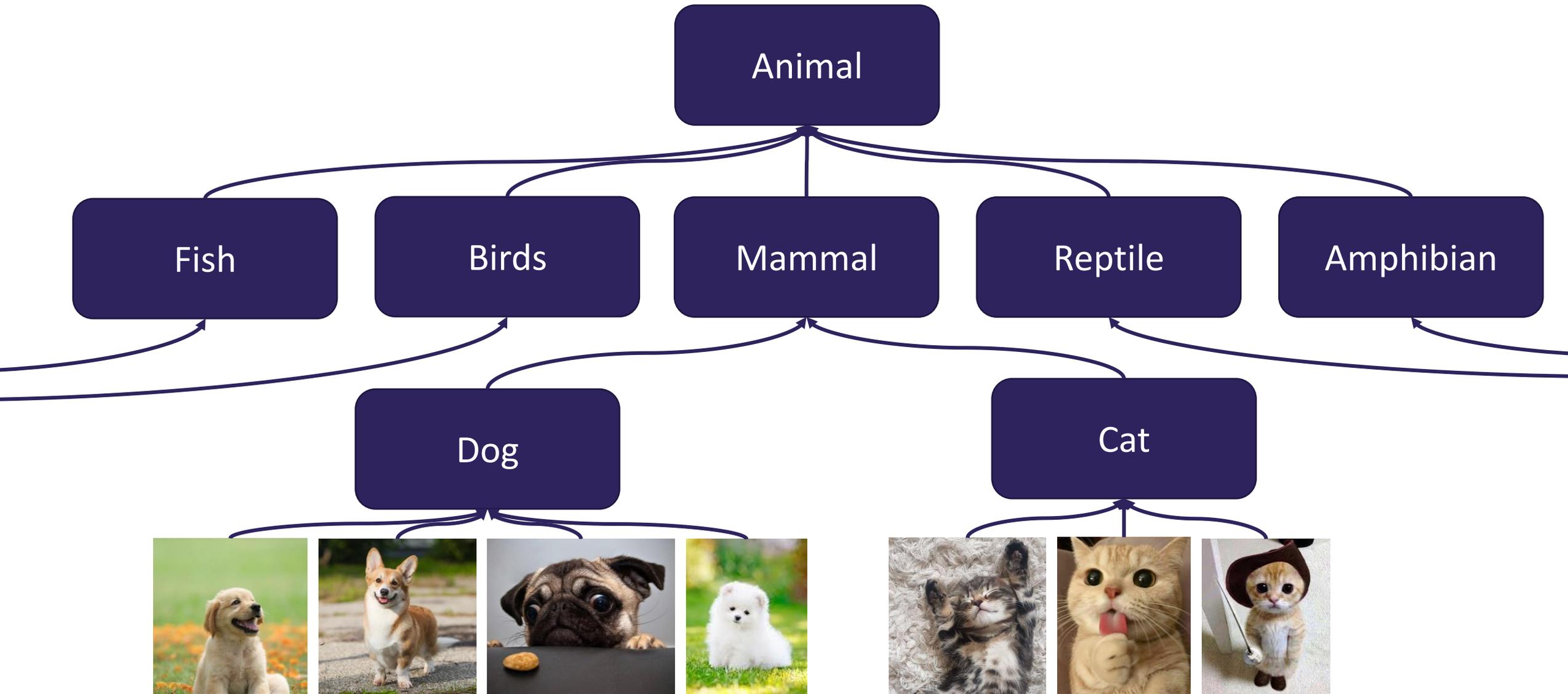
Announcements

- Creative Project 0 due tonight, Wed April 9 at 11:59pm!
 - See generic [Creative Project rubric](#) posted on website
- Programming Assignment 0 will be released tomorrow, Thurs April 9
 - Focused on inheritance and abstract classes

Lecture Outline

- **Polymorphism Review** 
 - Declared vs. Actual Type
 - Compiler vs. Runtime Errors
- Abstract Classes Review
- Pre/Post conditions and commenting

Review: Is-a Relationships



Polymorphism

- `DeclaredType` x = new `ActualType`()
 - All methods in `DeclaredType` can be called on x
 - We've seen this with interfaces (`List<String>` vs. `ArrayList<String>`)
 - Can also be to inheritance relationships

```
Animal[] arr = {new Dog(), new Cat(), new Bear()};  
for (Animal a : arr) {  
    a.feed();  
}
```

Compiler vs. Runtime Errors

- **DeclaredType** x = new **ActualType**()
 - At compile time, Java only knows **DeclaredType**
 - Compiler error (CE): trying to call a method that isn't present

```
Animal a = new Dog();
a.bark(); // No bark() -> CE
```
 - Can cast to change the **DeclaredType** of an object

```
((Dog) a).bark(); // No more CE
```
 - Runtime error (RE): attempting to cast to an invalid **DeclaredType***

```
Animal a = new Fish();
((Dog) a).bark(); // Can't cast -> RE
```
 - Order matters! Compilation before runtime

Declared Type and Actual Type

```
DeclaredType varName = new ActualType(...);
```

```
Animal bucky = new Dog("Bucky");
```

Declared Type: Animal

Actual Type: Dog

Can call methods that makes sense for EVERY Animal
If Dog overrides a method, uses the Dog version

```
Dog bucky = new Dog("Bucky");
```

Declared Type: Dog

Actual Type: Dog

Can call methods that makes sense for EVERY Dog
If Dog overrides a method, still uses the Dog version

Compiler vs. Runtime Errors

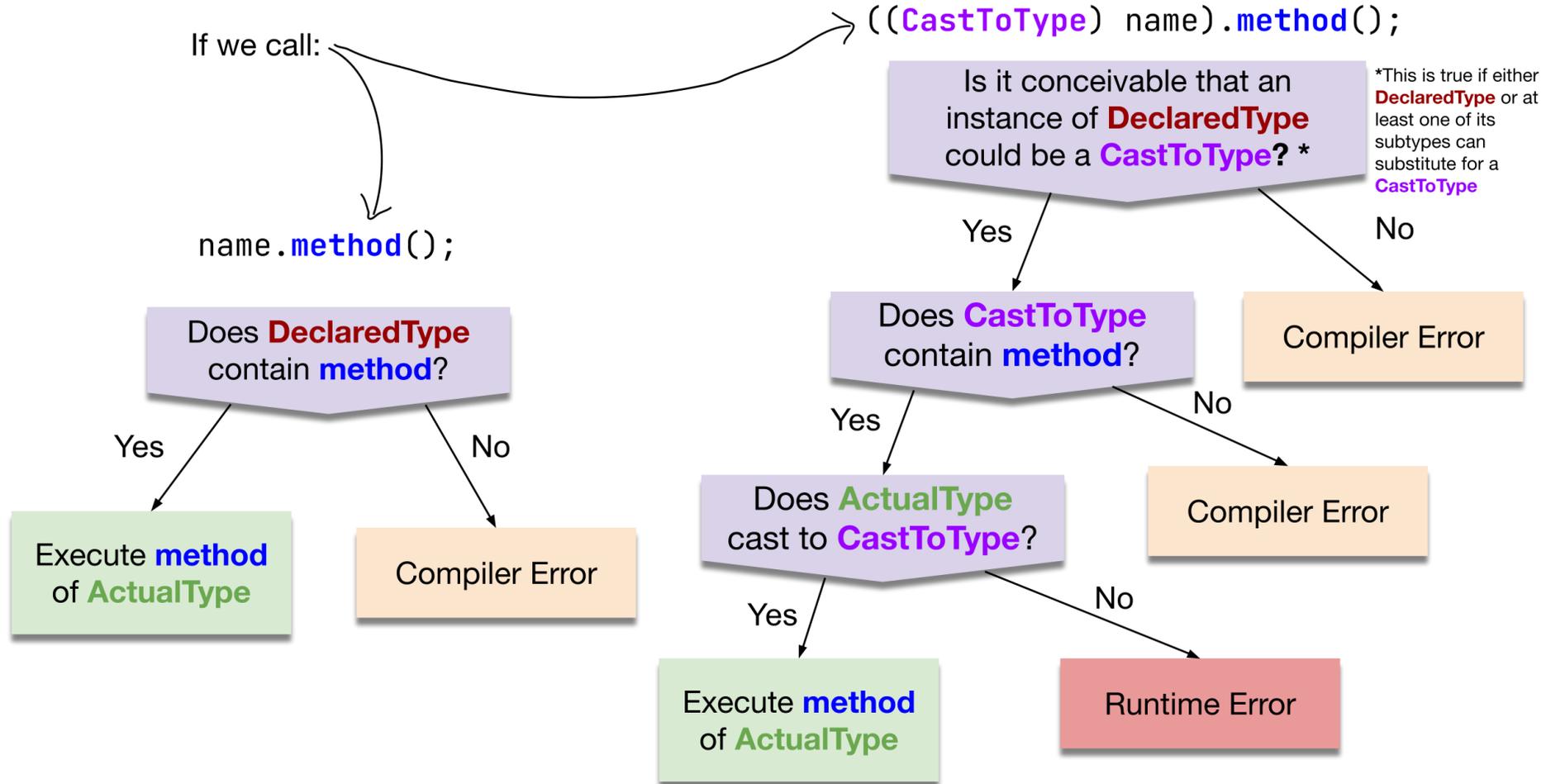
With the following declaration and initialization:

```
DeclaredType name = new ActualType();
```

If we call:

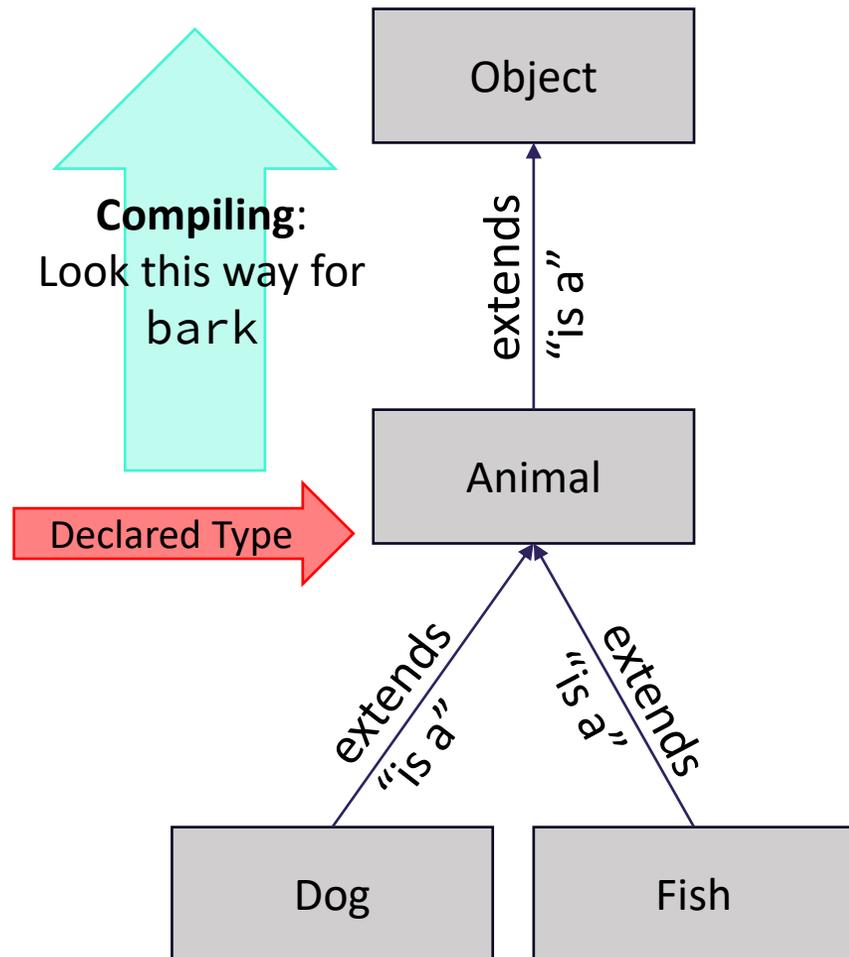
```
name.method();
```

```
((CastToType) name).method();
```



Inheritance and Method Calls

```
Animal bucky = new Dog();  
bucky.bark();
```



When compiling:

Can we *guarantee* that the method exists for the **declared type**?

Does the **declared type** or one of its super classes contain a method of that name?

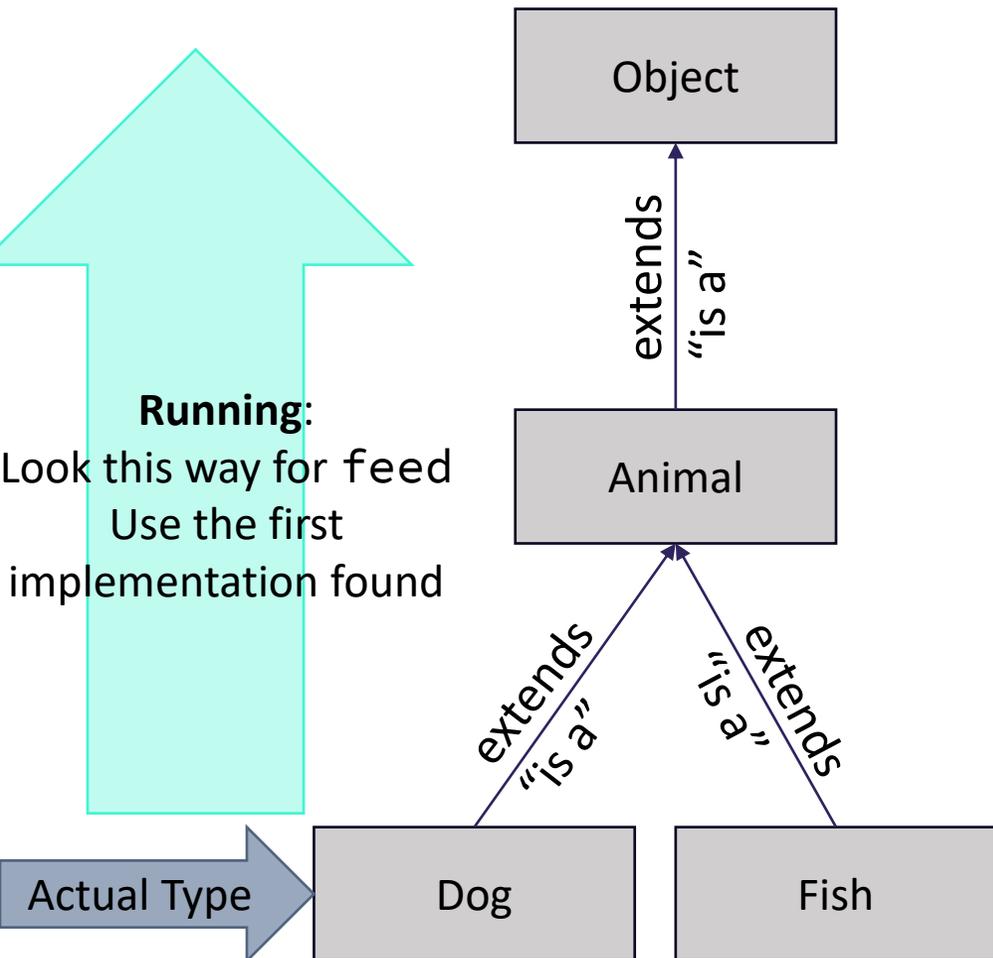
If not... Compile Error!

In this example:

When compiling, neither **Animal** nor **Object** have a **bark** method, so we have a compile error!

Overrides and Method Calls

```
Animal bucky = new Dog();  
bucky.feed();
```



When running:

Use the *most specific* version of the method call starting from the **actual type**.

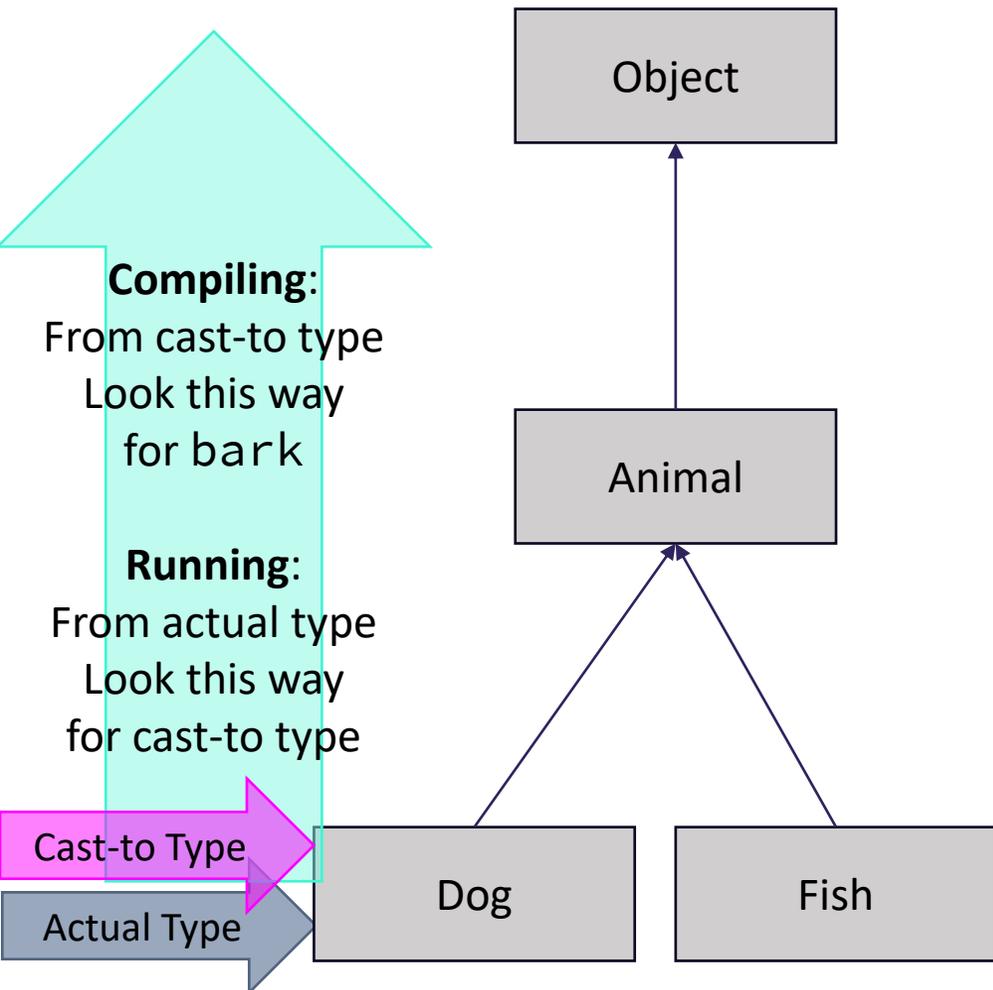
Start from the **actual type**, then go “up” to super classes until you find the method. Run that first-discovered version.

In this example:

If the Dog class overrides feed, then we’ll use the implementation in Dog. Otherwise we’ll use the one in Animal

Casting and Method Calls

```
Animal bucky = new Dog();  
((Dog) bucky).bark();
```



When compiling:

Can we *guarantee* that the method exists for the **Cast-to type**?

Does the **Cast-to type** or one of its super classes contain a method of that name?

If not... Compile Error!

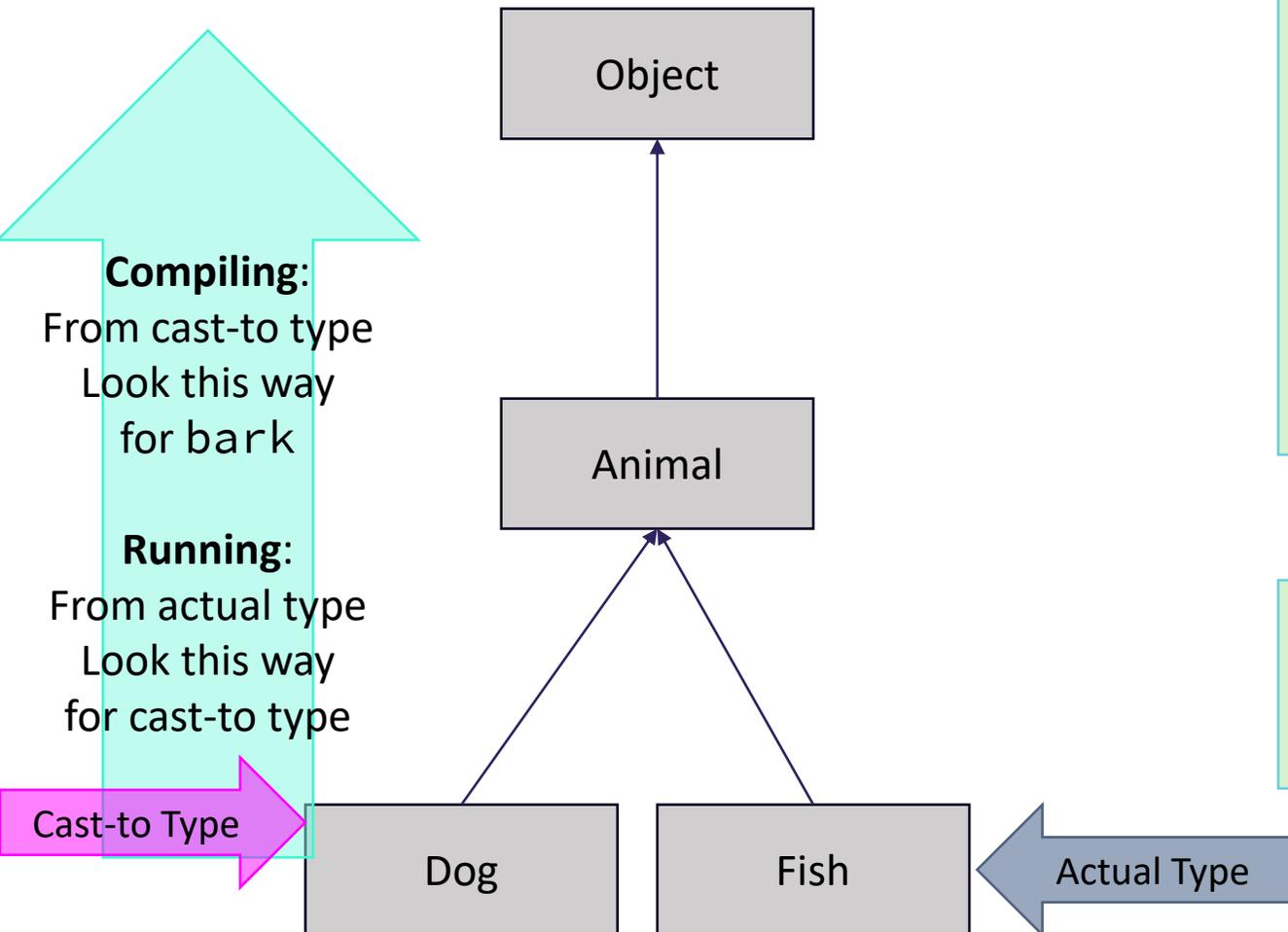
When Running:

Check that the **Cast-to Type** is either the **Actual Type**, or one of its super classes

This example has no error

Casting and Method Calls

```
Animal bucky = new Fish();  
((Dog) bucky).bark();
```



When compiling:

Can we *guarantee* that the method exists for the **Cast-to type**?

Does the **Cast-to type** or one of its super classes contain a method of that name?

If not... Compile Error!

When Running:

Check that the **Cast-to Type** is either the **Actual Type**, or one of its super classes

This example has a runtime error



Practice

What results from the following code being executed? (1)

```
Animal bucky = new Dog();  
bucky.bark();
```

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error



Practice

What results from the following code being executed? (2)

```
Animal bucky = new Dog();  
((Dog) bucky).bark();
```

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error



Practice

What results from the following code being executed? (3)

```
Animal bucky = new Dog();  
((String) bucky).meow();
```

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error



Practice

What results from the following code being executed? (4)

```
Animal bucky = new Dog();  
((Reptile) bucky).slither();
```

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error

Lecture Outline

- Polymorphism Review
 - Declared vs. Actual Type
 - Compiler vs. Runtime Errors
- **Abstract Classes Review** ◀
- Pre/Post conditions and commenting

Abstract Classes

- Mixture of Interfaces and Classes

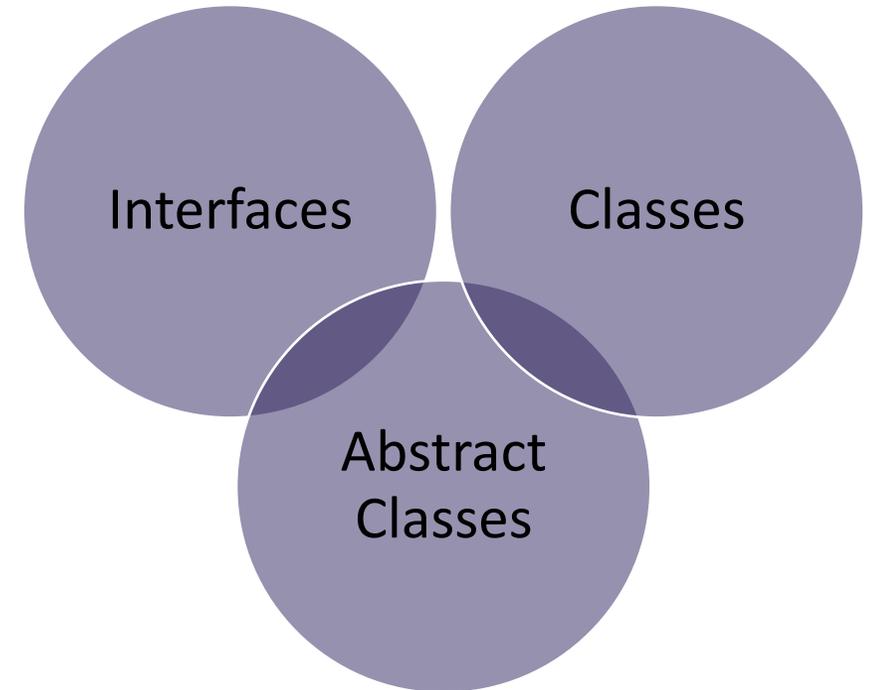
- Interface similarities:

- Can contain (abstract) method declarations
 - Can't be instantiated

- Class similarities:

- Can contain method implementations
 - Can have fields
 - Can have constructors

- Is there identical / nearly similar behavior between classes that shouldn't inherit from one another?



Shape / Square / Circle Example

The starter code contains `Shape`, `Square`, and `Circle` classes similar to the pre-class work, as well as a `Client` that prints out a couple of shapes.

- Add an abstract `getName` method to the `Shape`.
 - Add implementations of `getName` to `Square` and `Circle` that return "Square" and "Circle".
- Add a method `isEmpty` to `Shape` that tells you whether the shape is empty (has zero area) or not.
 - Hint: you will need to call `getArea`, but it may not immediately work...
- Implementing `isEmpty` by calling `getArea` works fine as is, but suppose we wanted to implement it in `Circle` directly. How could we do this just by looking at the fields of the `Circle`? Implement it this way by overriding `isEmpty` in `Circle`.
- Override `toString` in `Shape` to return a similar message to what the `Client` prints in the starter code:
 - Hint: your `toString` can call abstract methods!
- Rewrite the `Client` class to use the new `toString` on shapes.

Advanced OOP Summary

- Allow us to define differing levels of abstraction
 - Interfaces = high-level specification
 - What behavior should this type of class have
 - Abstract classes = shared behavior + high-level specification
 - Classes = individual behavior implementation
 - Inheritance allows us to share code via “is-a” relationships
 - Reduce redundancy / repeated code & enable polymorphism
 - Still might not be the “best” decision!
 - Interfaces extend other interfaces
 - (abstract) classes extend other (abstract) classes
- You’re now capable of designing some pretty complex systems!

Abstract

Interfaces

Abstract
Classes

Classes

Concrete

Design in the “real world”

- In this course, we’ll always give you expected behavior of the classes you write
 - Often not the case when programming for real
 - Clients don’t really know what they want (but programmers don’t either)
- My advice:
 - Clarify assumptions before making them (do I really want this functionality?)
 - **There’s no one right answer**
 - Weigh the options, make a decision, and provide explanation
 - Iterative development: make mistakes and learn from them
 - Be receptive to feedback and be willing to change your mind

Interface versus Implementation

- Interface: what something *should* do
- Implementation: *how* something is done
- These are different!
- Big theme of CSE 123:

choose between different implementations of same interface