LEC 02

CSE 123

Abstract Classes

Questions during Class?

Raise hand or send here

sli.do #cse123

BEFORE WE START

Talk to your neighbors:

Coffee or tea? Or something else?

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Arohan	Neha	Rushil	Johnathan	Nicholas
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Amy	Packard	Cora	Dixon	Nichole
Trien	Lawrence	Liza	Helena	

Music: CSE 123 25wi Lecture Tunes

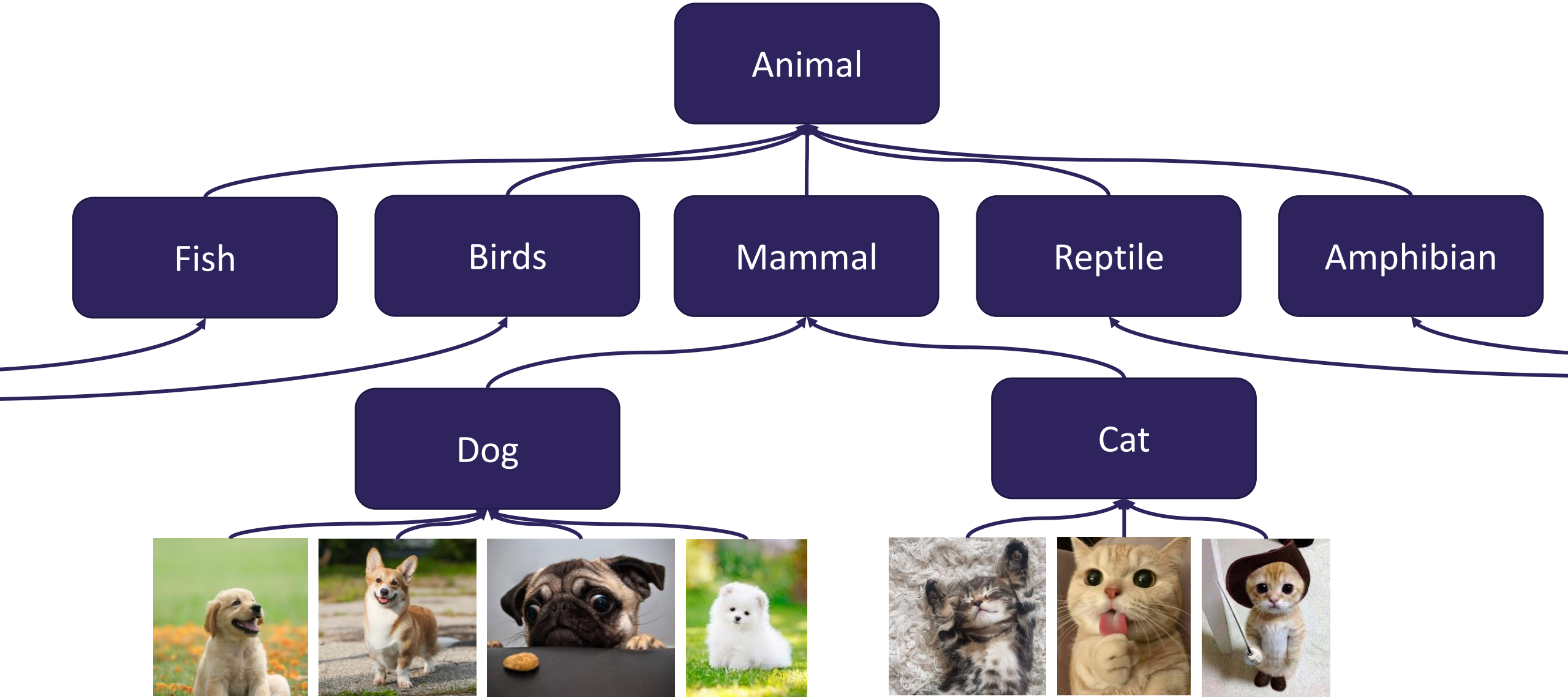
Announcements

- Review sessions held on Monday Jan 13
  - Recordings are linked from the course calendar
- Creative Project 0 due tonight, Wed Jan 15 at 11:59pm!
  - See generic Creative Project rubric posted on website
- Programming Assignment 0 will be released tomorrow, Thurs Jan 16
  - Focused on inheritance and abstract classes
- NOTE: Monday, Jan 20 is a university holiday (MLK Jr. day) so campus will be closed
  - Instructor office hours will be cancelled
  - IPL will be closed
  - Message board will still be available, but response time may vary

Lecture Outline

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

Review: Is-a Relationships



Review: 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

Compiler vs. Runtime Errors

With the following declaration and initialization:

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

If we call:

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

Does **DeclaredType** contain **method**?

- Yes → Execute **method** of **ActualType**
- No → Compiler Error

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

Is it conceivable that an instance of **DeclaredType** could be a **CastToType**? *

*This is true if either **DeclaredType** or at least one of its subtypes can substitute for a **CastToType**

- Yes → Does **CastToType** contain **method**?
  - Yes → Does **ActualType** cast to **CastToType**?
    - Yes → Execute **method** of **ActualType**
    - No → Runtime Error
  - No → Compiler Error
- No → Compiler Error

Practice : Think

sli.do #cse122

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

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

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error

Practice : Pair

sli.do #cse122

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

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

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error

Practice : Think

sli.do #cse122

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

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

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error

Practice : Pair

sli.do #cse122

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

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

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error

Practice : Think

sli.do #cse122

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

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

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error

Practice : Pair

sli.do #cse122

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

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

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error

Practice : Think

sli.do #cse122

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

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

A. Compiler Error

B. Runtime Error

C. Compiles and runs without error

Practice : Pair

sli.do #cse122

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

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

A. Compiler Error

B. Runtime Error

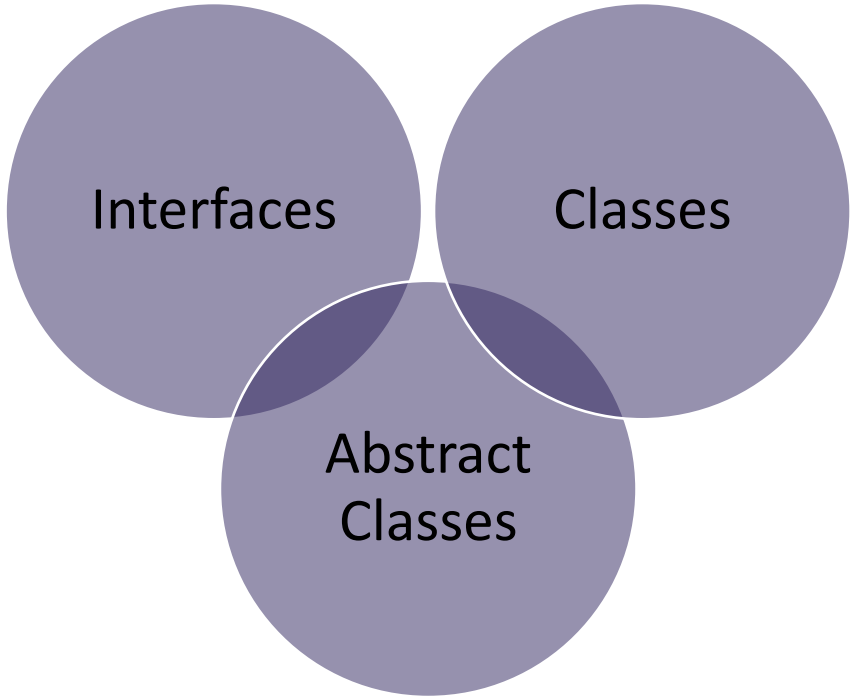
C. Compiles and runs without error

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



- 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!

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