

Inheritance and Subtyping

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Opening Discussion

- Do you have any thoughts about what project you want to do?
- Minute essay comments:
 - How do you access companion objects?
 - How do class instances interact?
 - Creating instances.

Abstraction

- A lot of this semester focuses on the idea of abstraction.
- We saw a little abstraction in the first semester, like having the ability to pass in different functions to perform different operations.
- This capability can be expanded greatly and gives us a lot of power.
- Remember that we don't want to write more code than we have to. In particular, duplicating code is very risky.

Polymorphism

- Literally means “many shapes”. In programming means “many types”.
- Our code to date has been monomorphic. It worked with only one type.
- We can add a lot of flexibility with polymorphism.
 - Write something once and have it work with many types.
- Universal polymorphism → works with infinite number of types

Inclusion Polymorphism

- One form of Universal Polymorphism is called Inclusion Polymorphism.
- We get this when we have that ability to say that one type is a subtype of another type.
- If B is a subtype of A, then any code that wants an instance of A can use an instance of B.
- Consider the type Fruit.

Inheritance

- The way we get inclusion polymorphism in Scala is through inheritance.
 - `class B(...) extends A(...) { ... }`
- This means B gets all the stuff from A.
 - For that reason, it can be safely used as a subtype.
 - Subtypes can override implementations.
- Only use inheritance to represent an “is a” relationship. Even then don't use it unless it makes sense.
- Let's consider the example of a shape.

Details

- Visibility
 - Private – subtypes can't get access, but have a copy of data.
 - Protected – subtypes can access, but other things can't.
- Call methods on supertypes with `super.method(...)`
- You can only inherit from one class.
- In UML this is shown as an open headed arrow from the subtype to the supertype.

Anonymous Classes

- It turns out you have been using inheritance for a long time.
 - `val frame = new MainFrame { ... }`
- This code actually makes a new class with no name. It is a subtype of `MainFrame`.
- Because it doesn't have a name of its own it is called an anonymous class.

Abstract Classes

- Often a supertype needs to have a method, but there is no general implementation.
- In this case, the method should be abstract. That simply means it isn't implemented.
- Classes with abstract members need to be declared abstract.
 - ```
abstract class Shape {
 def area:Double
```
  - ```
}
```
- Abstract classes can't be instantiated.

Traits

- A trait is like an abstract class that can't take arguments.
- You can inherit from multiple traits.
 - `class B extends A with T1 with T2 ... { ... }`
- If methods are duplicated, it searches for the one to use starting at the end of the list and working backward (plus some other details).

final

- Sometimes you have methods that shouldn't be overridden or classes that shouldn't be inherited from. In that case you make them final.
- For example, immutable classes need to be final so that people can't make mutable subtypes.

Inheriting from Function Types

- As you know, functions are used in many places in Scala.
- If you provide an apply method, you can have your class inherit from a function type.
- This would let you pass instances of your function into methods that want functions.

Minute Essay

- Questions?
- How might inheritance and subtyping be used in your project?
- Next class we will use this in our project.