Object Oriented Programming in Rust

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Logistics

- Week 3 exercises due today at 11:59 PST.
  - Please let us know if you get stuck / feel confused! We want you to sleep!
- Using myth? See announcements channel
- Participation incentive: At the end of the quarter, I'll randomly select at least 3 people that participated 10 times throughout the quarter, and I'll make you a custom mug or pot (see @pottedpeasceramics)
  - Asking or answering a question in lecture (out loud, or in the chat) or on Slack all count as participation
- Today: How can we write good code in Rust?

Object Oriented Programming in C++

Classes

- "Object" Oriented: Create an 'object' - movie database, and you can performs **methods** on this object.
- You can create **instances** of objects, and each would have their own set of variables. (Movie database with different files)
- Classes divided into **public** and **private** regions.
- **public** members can be accessible to anyone with reference to an instance
- **private** members only accessible to the implementer of the class

```
class imdb {
  public:
    imdb(const std::string& directory)
    bool getCredits(...)
  private:
    /* Elements
    const char* kActorFileName;
}
```

What are some advantages to Classes?

Advantages to Class Design

- **Code-Reuse:** Want an object to be different based on the file it takes in? Add one parameter to its constructor, and suddenly you have two different implementations, but just one class!
- **Code-Hiding**: Don't need to expose parts of a class not needed for a user to interact with it. Could lead to misuse, and add too much overhead to contribute to a project.

Code-Reuse

```
class TeddyBear {
  public:
    TeddyBear(..);
    void roar_sound();
}
```

```
class PurpleTeddyBear {
  public:
    TeddyBear(..);
    void roar_sound();
    void purple_button_song();
}
```

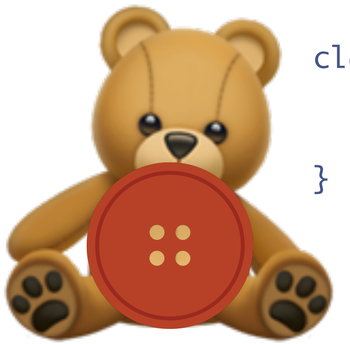
```
class RedTeddyBear {
  public:
    TeddyBear(..);
    void roar_sound();
    void red_button_song();
}
```

```
class PurpleTeddyBear {
  public:
    TeddyBear(..);
    void roar_sound();
    void green_button_song();
}
```

We still have to repeat a bunch of code!

Inheritance

```
class TeddyBear {
   public:
      TeddyBear(..);
      void roar_sound();
}
```



```
class RedTeddyBear {
   public:
      red_button_song();
}
```

```
class PurpleTeddyBear {
   public:
      purple_button_song();
}
```

```
class GreenTeddyBear {
   public:
      green_teddy_bear();
}
```

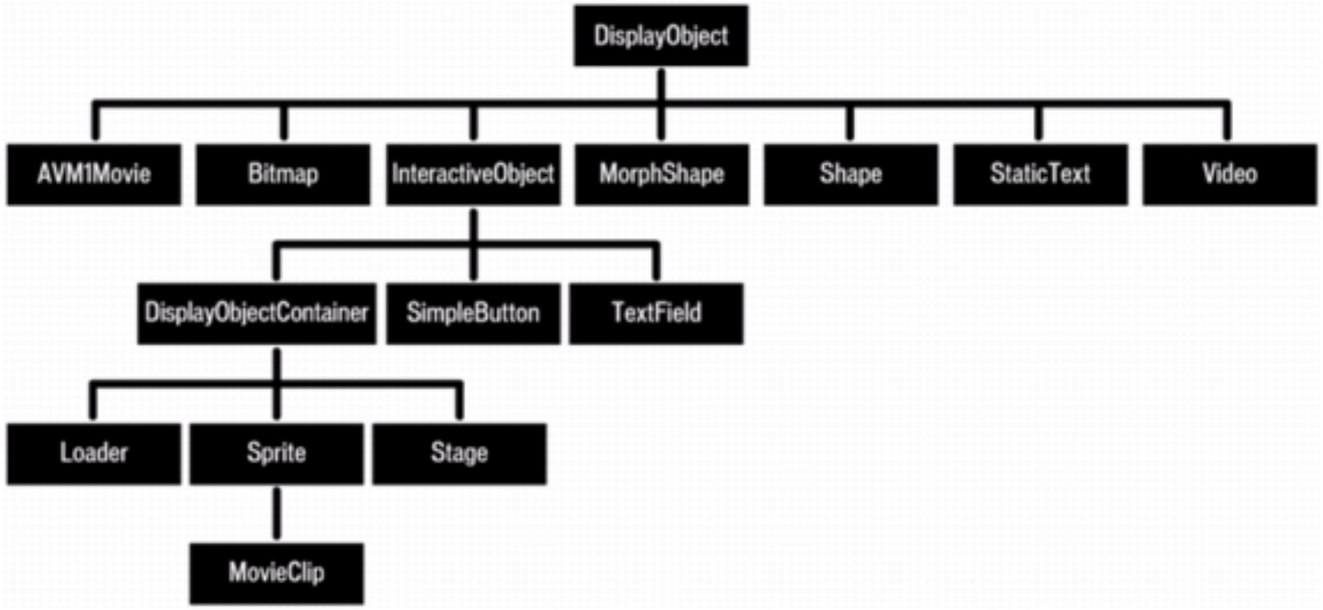
Lets take a look!

Inheritance

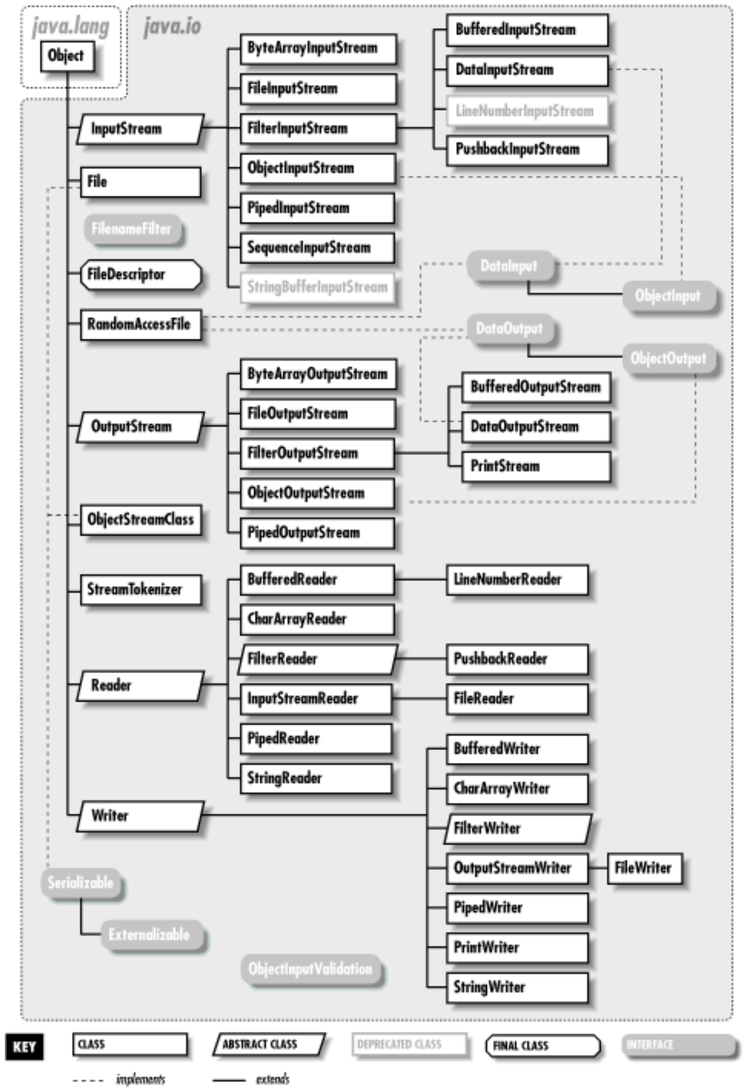
- With Inheritance, we were able to use the same implementation of one method across many different kinds of objects, brought together through a **parent-child** relationship.
- Child subclasses inherit **all** methods and attributes. (*constructors usually don't count here, depending on the language).* They can choose to override parent functions (green bear roaring differently)
- Big concept in languages like Java (where everything inherits one base **Object** class)

What might be the weaknesses of Inheritance?

Inheritance Trees



A Change in DisplayObject could break implementations for the entire tree!



Questions?

Traits

How else can we decompose?

https://play.rust-lang.org/?version=stable&mode=debug&edition=2018&gist=da8b2ac99e2c386656cb103c277a014e

```
struct TeddyBear;

impl TeddyBear {
  fn roar(&self) {
    println!("ROAR!!");
  }
}
```

```
struct PurpleTeddyBear;

impl PurpleTeddyBear {
  fn roar(&self) {
    println!("ROAR!!");
  }
  fn purple_button_song(&self){
    /* Purple Song */
  }
}
```

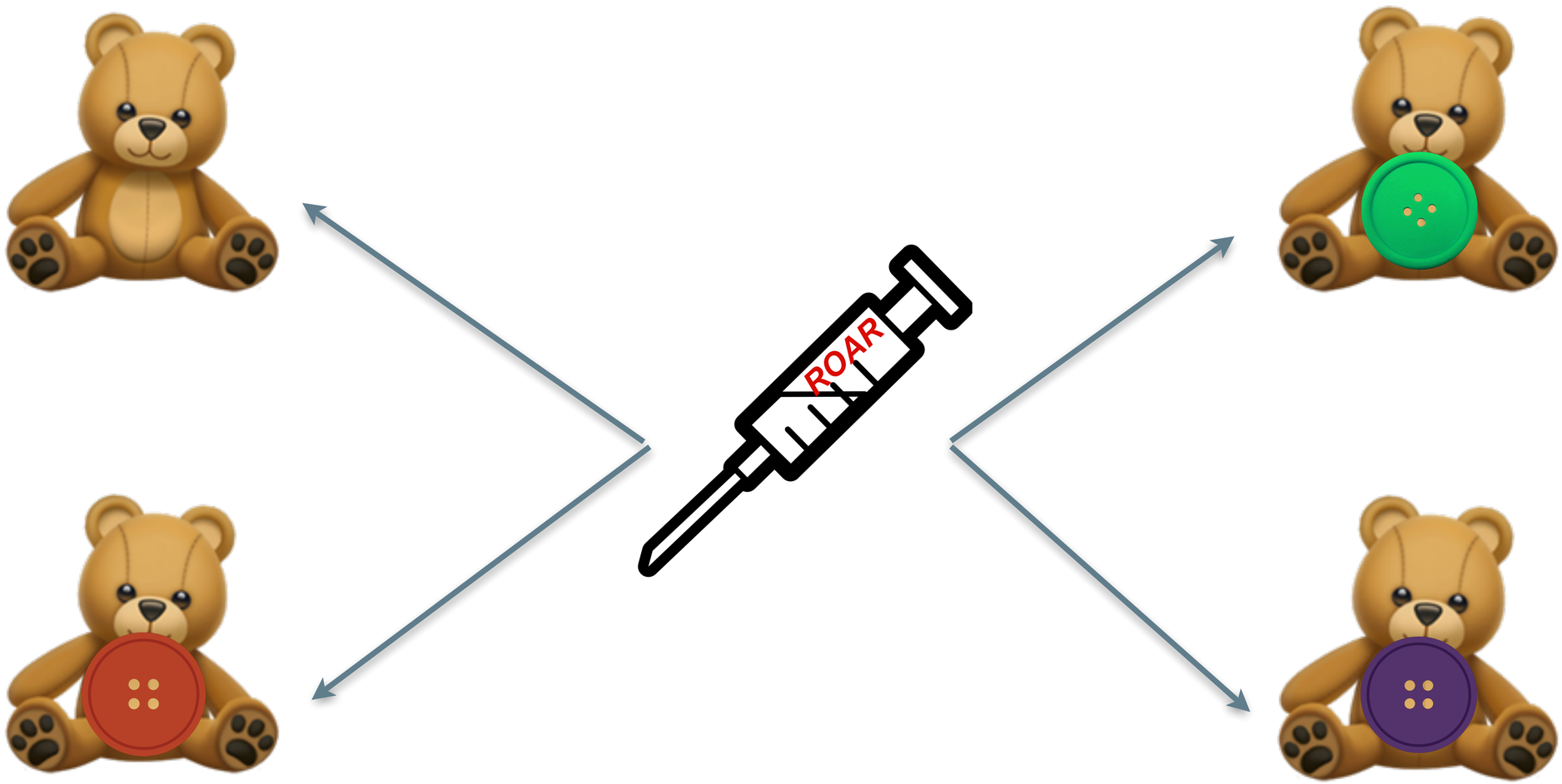
```
struct RedTeddyBear;

impl RedTeddyBear {
  fn roar(&self) {
    println!("ROAR!!");
  }
  fn red_button_song(&self){
    /* Red Song */
  }
}
```

```
struct GreenTeddyBear;

impl GreenTeddyBear {
  fn roar(&self) {
    println!("ROAR!!");
  }
  fn green_button_song(&self){
    /* Green Song */
  }
}
```

Traits



Inject the code you want into the other classes! (Inject a trait into them!)

Let's make our first trait!

Traits Overview

- With traits, you write code that can be **injected** into any existing structure. (From TeddyBear to i32!) This code can have reference to **self,** so the code can be dependent on the instance
- Trait methods do not need to be fully defined - you could define a function that must be implemented when implementing a trait for a type. (Similar to Java interfaces)
- No more deep inheritance hierarchies. Just think: "Does this type implement this trait?"
- Traits can specify functions instances **should** have, instead of just getting many from another "parent".

Advantages to Traits

- **Code-Reuse:** Want an object to be different based on the file it takes in? Create a *Trait* that has a parameterized function, and inject it to all objects!
- **Code-Hiding**: All parts of a trait are exposed, but because you specify which members / functions should be injected, there is no accidental spillover that inheritance structures can have!

Questions?

Big Standard Rust Traits

Traits to Know

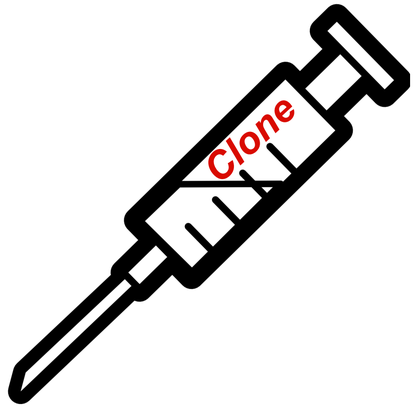
- **Copy:** Will create a new copy of an instance, instead of moving ownership when using assignment (=)
- **Clone:** Will return a new copy of an instance when calling the .clone() function on the method.
- **Drop:** Will define a way to free the memory of an instance - called when the instance reaches the end of the scope.
- **Display:** Defines a way to format a type, and show it (used by println!)
- **Debug:** Similar to Display, though not meant to be user facing (Meant for you to debug your types!)
- **Eq:** Defines a way to determine equality (defined by an equivalence relation) for two objects of the same type.
- **PartialEq:** Defines a way to determine equality (defined by a partial equivalence relation) - f32!

Lets implement a standard Trait!

```
struct Point {
    x: u32,
    y: u32,
}

fn main() {
  let pt = Point {x:3, y:2};
  let pt2 = pt.clone();
}
```

Does not compile - clone() isn't defined



Let's Inject Clone!

Injecting Clone

- You can implement any traits into any structure (as we did with Clone to Point), so long as they are compatible (**Drop** is not compatible with **Copy**)
- You can use the Rust Documentation as a way to tell you which functions need to be implemented, along with their parameter types.
- You can use **#[derive(x,y,z..)]** to *derive* traits. The Rust compiler will try to implement the traits for you, if your structure satisfies some rules (given by the documentation). IE: You can derive Clone if all members in the struct already implement Clone.

Next Time [End]

- How can we write code that can accept many types?
- How can traits play a role in this?