CS 535 Object-Oriented Programming & Design
Fall Semester, 2008
Doc 11 Abstract Classes
Oct 2 2008

References

Object-Oriented Design Heuristics, Riel

Abstract Classes

Abstract class	Concrete class
A class that can not be instantiated	A class that can be instantiated

Why Abstract Classes

Define an abstraction
Define a type
Define interface for subclasses
Define methods for subclasses
Hide the existence of concrete subclasses

Defining Abstract Classes

Some languages have special syntax

```
public abstract  class  NoObjects  {
   public  void  aFunction()  {
      System.out.println(  "Hi Mom"  );
   }
   public  abstract  void  subClassMustImplement(  int  foo  );
}
```

Defining Abstract Classes - Smalltalk

Mark methods as abstract with “self subclassResponsibility”

```
Collection>>do: aBlock
   self subclassResponsibility
```

Indicate class is abstract in class comment

Include list of abstract methods

Browser will create methods stubs in subclass

What does self subclassResponsibility do?

Informs reader
- Method is abstract
- Concrete subclasses need to implement the method

Raises an exception when executed to indicate
- Subclass did not implement an abstract method
- Created an instance of an abstract class

Informs browser which methods subclasses need to implement

How to Prohibit Instances of Abstract Class

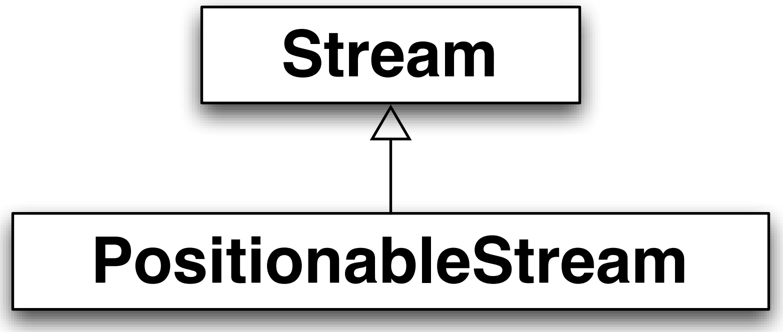
Documentation is normally enough

Implement new so it throws an exception

```
Stream class>>new
   "Provide an error notification that Streams are not created
   using this message."
   self error: ('Streams are created with on: and with:')
```

How do subclass objects get created?

```
Stream class>>new
   self error: ('Streams are created with on: and with:')
```



```
PositionableStream class>>on: aCollection
   ^super new on: aCollection
```

What happens when this is done?

```
    PositionableStream on: String new
```

How do subclass objects get created?

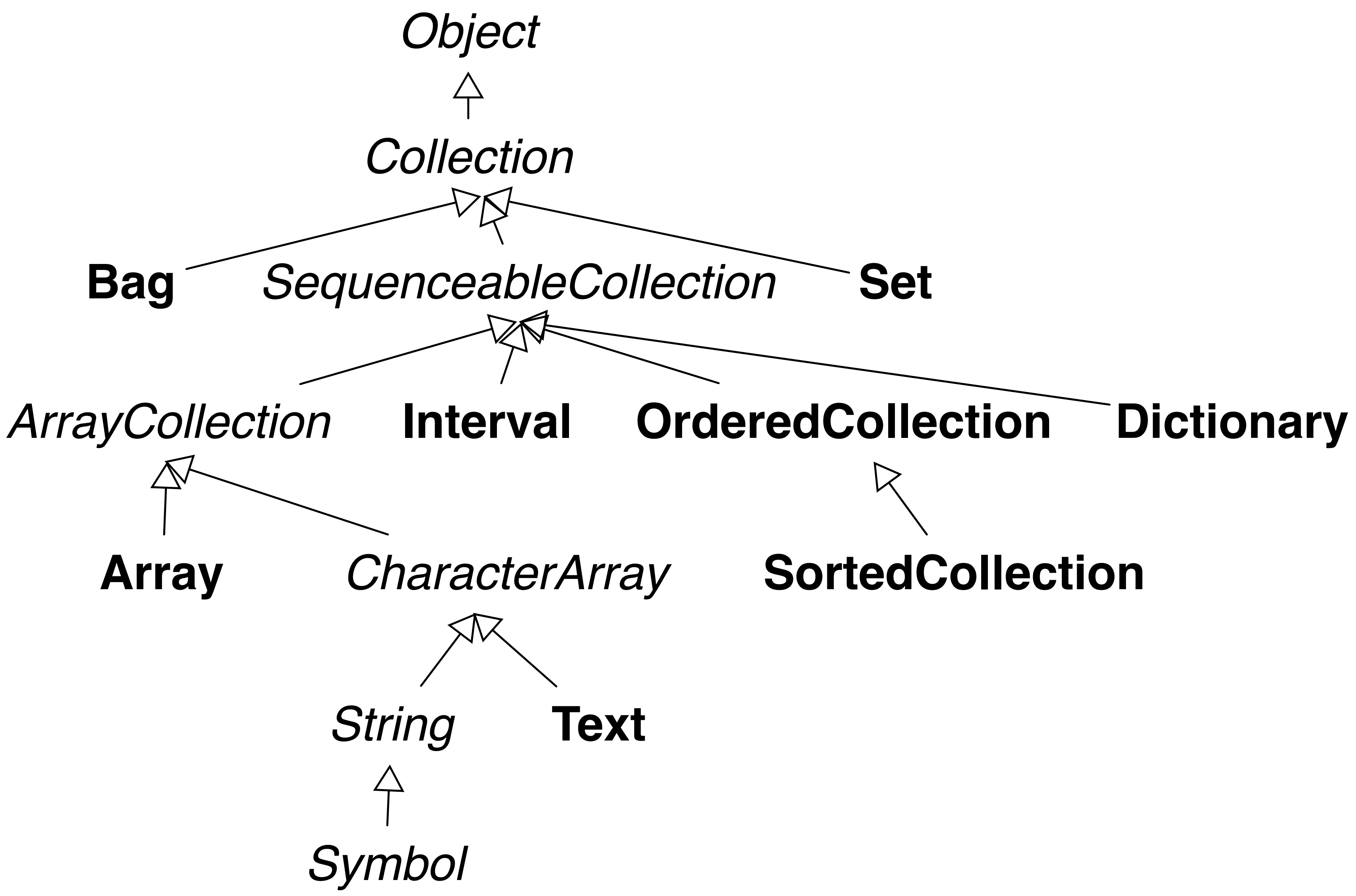
Use basicNew

```
PositionableStream class>>on: aCollection
   ^self basicNew on: aCollection
```

basicNew

- Does the same thing as new
- Is used to get around super class’s new method
- Only used in class instance creation methods
- Never implement basicNew

Smalltalk Collections



Italic - Abstract Class

Bold - Concrete class

Abstract Classes and Data

Abstract classes commonly do not have instance variables

How can they implement methods?

- Identify a core set of abstract operations

- Implement other methods using core methods

Collection Class

No instance variables

60 methods

Three abstract methods

- add:
- remove:ifAbsent:
- do:

Use three abstract methods to implement other 57 methods

```
detect: aBlock ifNone: exceptionBlock
	"Evaluate aBlock with each of the receiver's elements as the argument.
	Answer the first element for which aBlock evaluates to true."

	self do: [:each | (aBlock value: each) ifTrue: [^each]].
	^exceptionBlock value
```

Abstract Classes, Types and Hinges

Tagging (declaring) a variable to be an Abstract class instance

Indicates which operations are allowed on the variable

Allows any subclass to be used in the variable

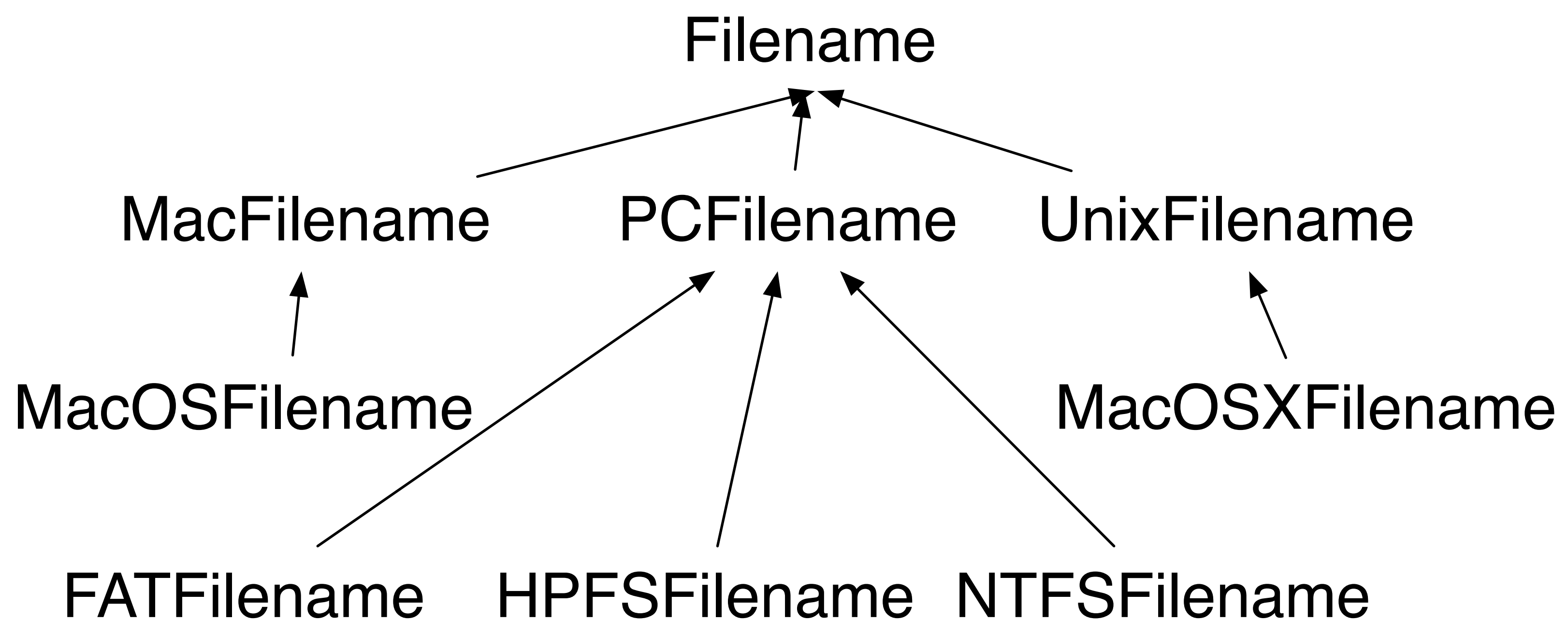
Provides flexibility particularly in languages with static type checking

```
SomeClass>>foo: aCollection
   ^aCollection fold: [:a :b | a max: b].

public class SomeClass {
   public int foo(Collection a) { blah}
}

public class Resticted {
   public int foo(Array a) { blah}
}
```

Abstract Classes and Hiding Subclasses



Smalltalk VM on startup informs Filename of the correct concrete class for the current platform

```
file := 'foo' asFilename.
file class                    "MacOSXFilename (on my machine)"
```

Platform Independence Aside

Mac, PC and Unix have different end of line characters

When you read a file:

- Smalltalk converts the platform's end of line character to cr

When you write a file

- Smalltalk converts cr to the platform's end of line character

Same code

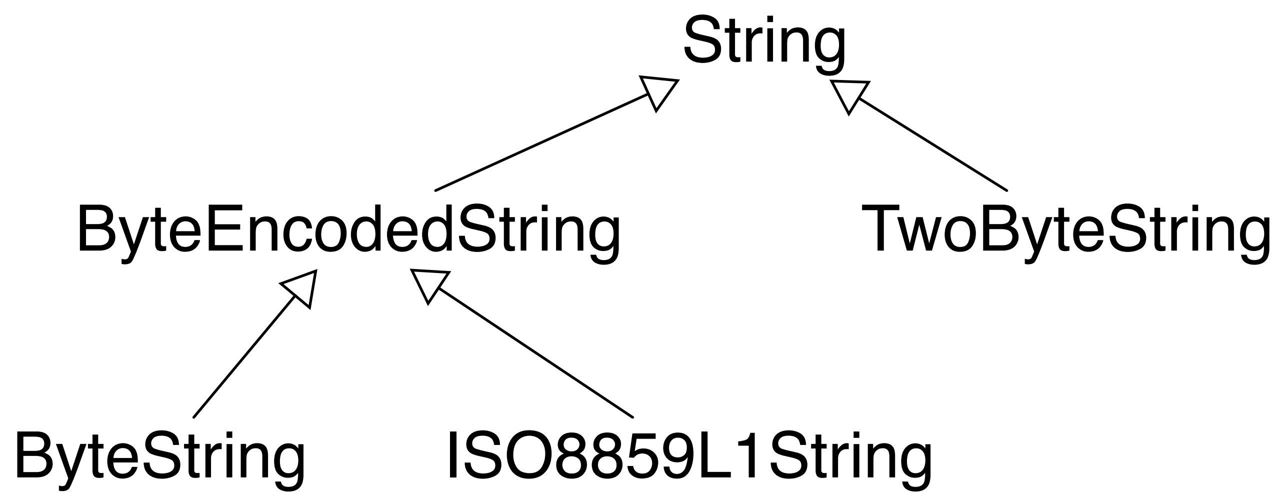
- Works on all three platforms
- Produces files with the correct end of line character

Hide the existence of concrete subclasses

String is an abstract class

String new
- Does not create a string object
- Creates an instance of a subclass
- Appears to create a String object

String subclasses
- Don’t add new methods
- Provide specific implementations



Strings Continued

```
| a |
a :=String new.
a class.              "returns ByteString"

| b |
b :=(String with: (Character value: 3585)) "3585 is Thai character".
b class              "returns TwoByteString"

| c |
c := String with: $a.
c class.             “returns ByteString”
c at: 1 put:  (3585 asCharacter).
c class              “returns TwoByteString”
```

To learn about character encodings read: http://www.joelonsoftware.com/articles/Unicode.html

become: Smalltalk Magic

```
| c |
c := String with: $a.
c class.                                "returns ByteString"
c at: 1 put:  (Character value: 3585).
c class                                 "returns TwoByteString"
```

How did c change class?

a become: b

Change all references to ‘a’ to reference ‘b’

Change all references to ‘b’ to reference ‘a’

‘a’ basically becomes ‘b’ and ‘b’ becomes ‘a’

String ClassTransformation without become?

Use composition

String has instance variable that holds real string

String forwards messages to the real string

String can replace the real string with a different object

Sample Implementation

```
Smalltalk.Core defineClass: #String
   superclass: #{Core.CharacterArray}
   instanceVariableNames: 'realString'

size
   ^realString size

at: anInteger
   ^realString at: anInteger

at: anInteger put: aCharacter
   aCharacter value > 256
      ifTrue: [realString := realString asTwoByteString].
   realString at: anInteger put: aCharacter.
```

Inheritance

What should I use as a super class?

A has a B

  Indicates that an instance variable of A is an instance of B

A is a B

A is a type of B

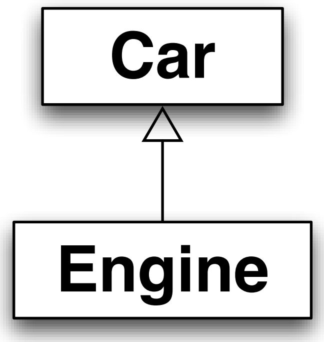
  Indicates that A is a subclass of B

A car has an engine, so car object contains an engine object

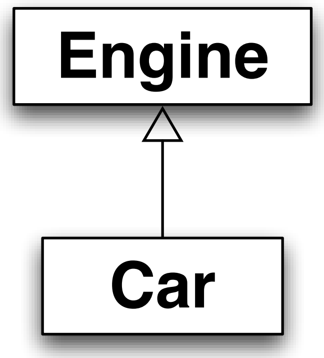
A BinarySearchTree has nodes, so it has instance variables left and right

A WordStream is a type of ReadStream so it is a subclass of ReadStream

Common Mistakes



Using has-a relation for inheritance

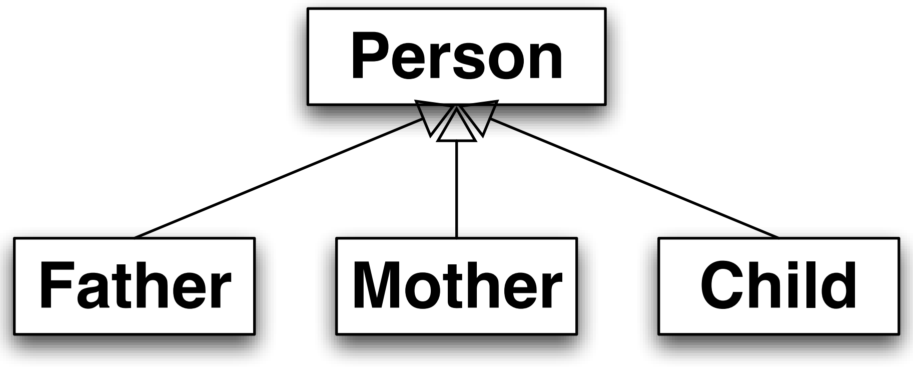


“I need access to engine methods in the car class and now I have it.”

Roles Verses Classes

2.11 Be sure the abstractions you model are classes and not simply the roles objects play

```
mother := Mother new.
father := Father new
```



```
mother := Person new.
father := Person new.
```