

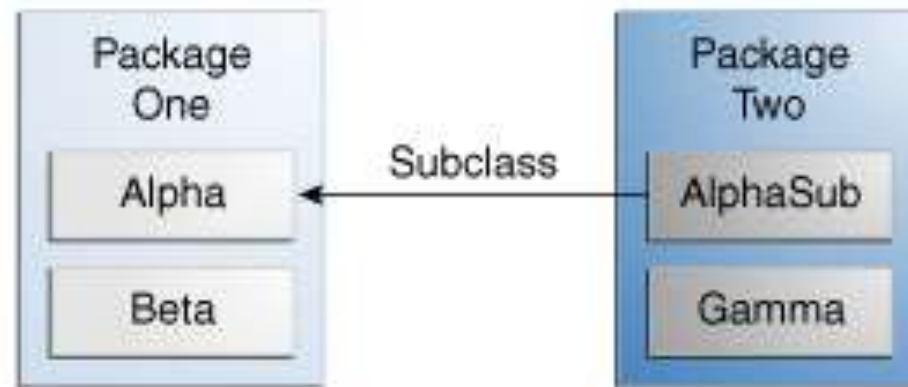
CSSE 220

Object & Polymorphism

Check out *Polymorphism* from SVN

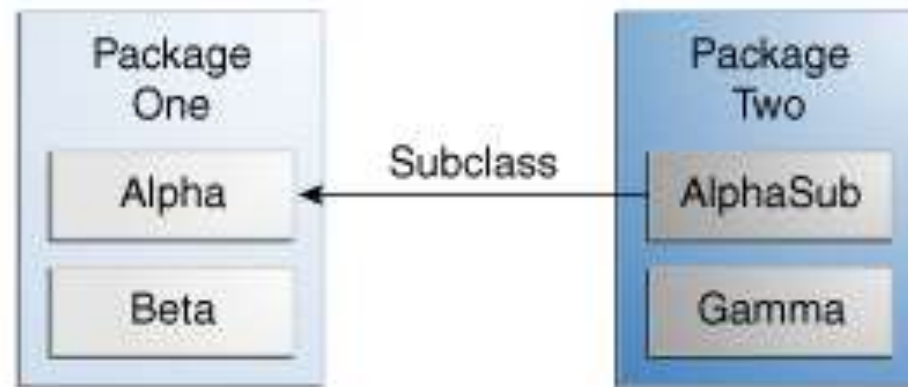
Access Levels: Review

Modifier	Class	Package	Subclass	World
public	Y	Y	Y	Y
protected	Y	Y	Y	N
<i>no modifier</i>	Y	Y	N	N
private	Y	N	N	N



Access Levels: Review

Modifier	Alpha	Beta	Alphasub	Gamma
public	Y	Y	Y	Y
protected	Y	Y	Y	N
<i>no modifier</i>	Y	Y	N	N
private	Y	N	N	N



Abstract Classes: Review

- ▶ Hybrid of superclasses and interfaces
 - Like regular superclasses:
 - Provide implementation of some methods
 - Like interfaces
 - Just provide signatures and docs of other methods
 - Can't be instantiated

▶ Example:

```
◦ public abstract class ChessPiece {  
    /** documentation here */  
    public abstract boolean checkMove(int dx, int dy);  
    ...  
}
```

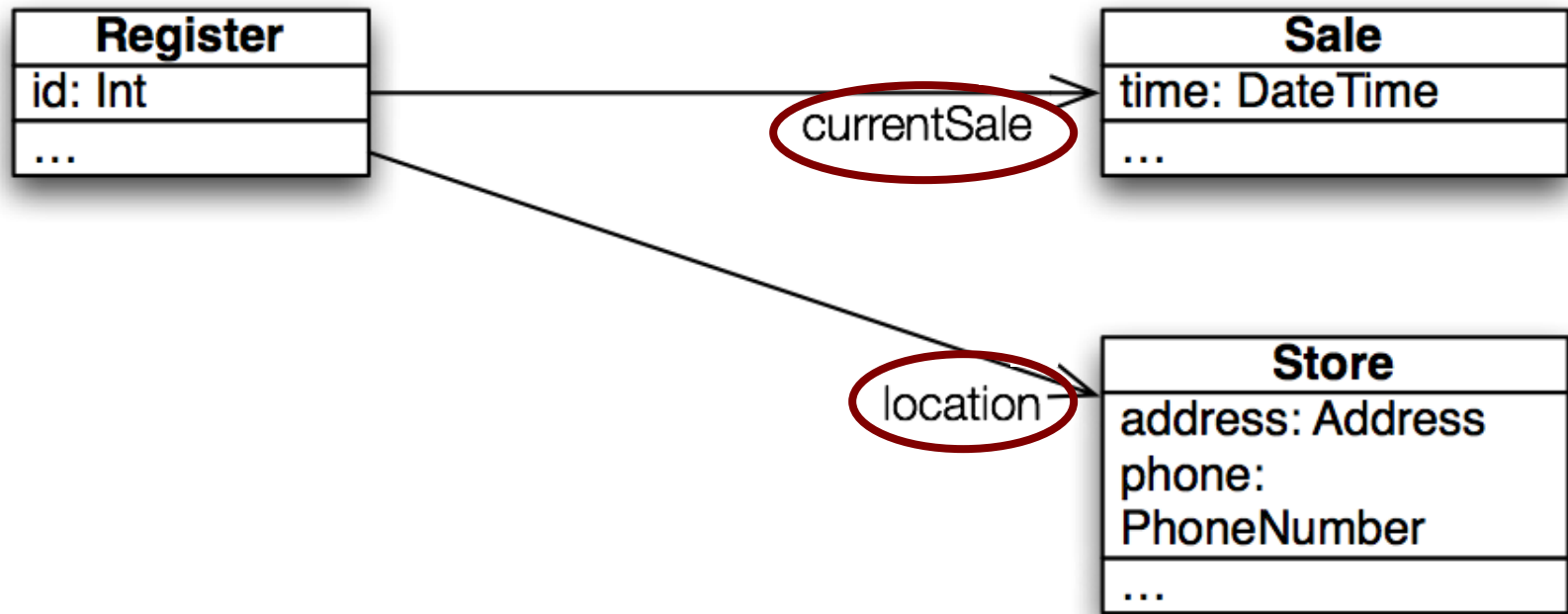


Elided methods as before

UML Class Diagram Review

- » Inheritance, Associations, and Dependencies

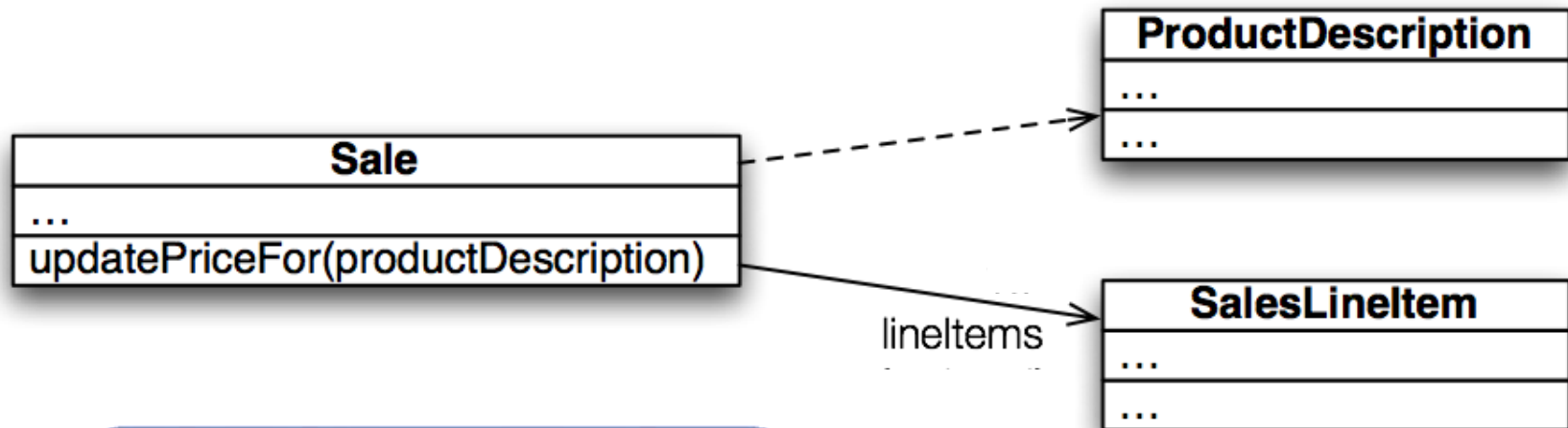
Recall UML: Associations



Solid line, open arrowhead = “has-a”

Recall UML: Dependencies

Dependency lines are dashed



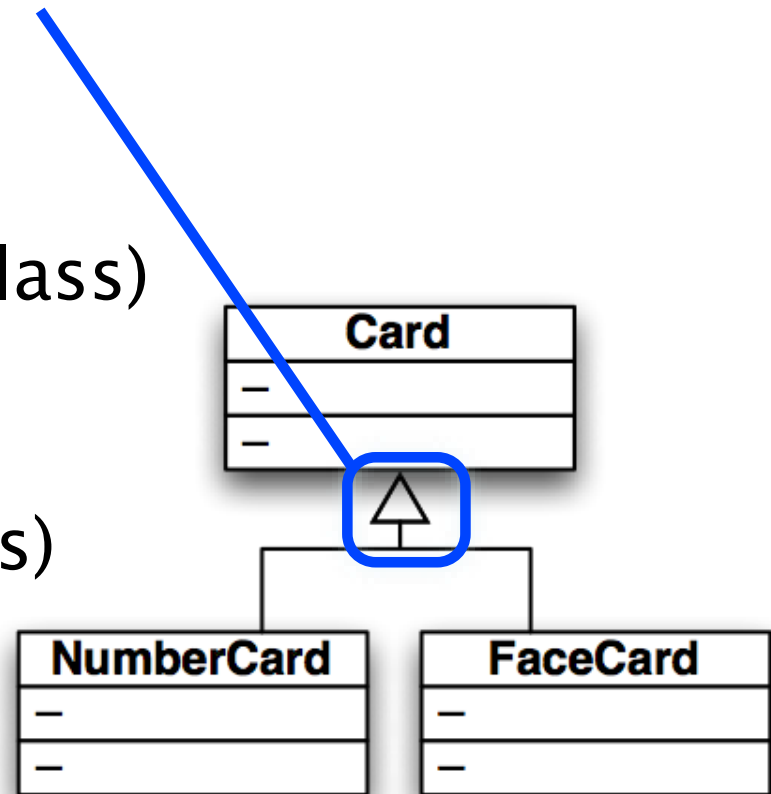
Field association lines are solid

Use association lines only when an item is stored as a field. Solid = stronger rel.

Two types of open arrowheads

Recall UML: Inheritance

- ▶ Generalization (superclass)
- ▶ Specialization (subclass)



Closed arrowhead = “is-a”.

Two types: solid line= inherits, dotted line = implements. Solid = stronger rel.

1, Object

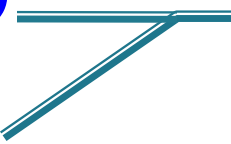


»» The superest class in Java

Object

*Every class in Java inherits from **Object***

- ▶ Directly and **explicitly**:
 - **public class String extends Object {...}**
- ▶ Directly and **implicitly**:
 - **class BankAccount {...}**
- ▶ **Indirectly**:
 - **class SavingsAccount extends BankAccount {...}**

Object Provides Several Methods

- ▶ **String toString()**  Often overridden
- ▶ **boolean equals(Object otherObject)**
- ▶ **Class getClass()**  Sometimes useful
- ▶ **Object clone()**  Often dangerous!
- ▶ ...

Overriding toString()

- ▶ Return a concise, human-readable summary of the object state
- ▶ Very useful because it's called automatically:
 - During string concatenation
 - For printing
 - In the debugger
- ▶ **getClass().getName()** OR **getClass().getSimpleName()** comes in handy here...

Overriding equals(Object o)

- ▶ `equals(Object foo)` - should return true when comparing two objects of same type with same “meaning”
- ▶ How?
 - Must check types—use **`instanceof`** OR **`getClass().isAssignableFrom(foo.getClass())`**
 - Must compare state—use **`cast`**

Recall casting a variable: Taking an Object of one particular type and “turning it into” another Object type

Polymorphism

»» Review and Practice

Recall: Polymorphism and Subclasses

- ▶ A subclass instance is a superclass instance
 - Polymorphism still works!

```
BankAccount ba = new SavingsAccount();  
ba.deposit(100);
```

- ▶ But not the other way around!

```
SavingsAccount sa = new BankAccount();  
sa.addInterest();
```

- ▶ Why not?



BOOM!

Summary

- ▶ If **B** extends or implements **A**, we can write

```
A x = new B ();
```

Declared type tells which methods x can access.
Compile-time error if try to use method not in A.

The actual type tells which class' version of the method to use.

- ▶ Can cast to recover methods from **B**:

```
((B) x) .foo ()
```

Now we can access all of B's methods too.

If x isn't an instance of B, it gives a run-time error (class cast exception)

Determining Method at Runtime

- ▶ Step 1: Identify the Declared/Casted Type
 - This is the item to the left of the variable name when the variable was declared:
 - BankAccount sa = new SavingsAccount();



Declared Type

- Declared Type may be changed due to a cast:
 - ((SavingsAccount)sa).addInterest();



Casted Type

- If there is a casted type, record that, otherwise use the declared type.

Determining Method at Runtime

- ▶ Step 2: Identify the Instantiation/Actual Type
 - This is the type on the right hand side of the equal sign the last time the variable was assigned to:
 - `BankAccount sa = new SavingsAccount();`



Instantiation Type

- Record the instantiation type

Determining Method at Runtime

▶ Step 3: Check for Compilation Errors

Calling a method that is not available based on the declared or casted type of the object

```
BankAccount sa = new SavingsAccount();
```

```
sa.addInterest();
```

Compiler Error: BankAccount does not have addInterest

Incompatible type assignment

```
SavingsAccount x = new BankAccount();
```

Compiler Error: BankAccounts can not be stored in SavingAccount typed variables

Invalid cast: casting to a type that isn't in the tree below the declaration type.

```
BankAccount sa = new SavingsAccount();
```

```
((SafetyDepositBox)sa).depositItem();
```

SafetyDepositBox is not below BankAccount.

Cannot instantiate interfaces or abstract classes!

Determining Method at Runtime

▶ Step 4: Check for Runtime Errors

Runtime errors are caused by invalid casting.

An item may only be cast to a type IF:

- The instantiation type matches the casted type
- The casted type is between Object and the instantiation type

```
BankAccount sa = new SavingsAccount();
```

```
((CheckingAccount)sa).deductFees();
```

Runtime Error: SavingsAccount is not a CheckingAccount

```
Account a = new CheckingAccount();
```

```
((BankAccount)a).deposit();
```

This is valid because a CheckingAccount is a BankAccount

Determining Method at Runtime

- ▶ Step 5: Find Method to Run
 - Find the instantiation type in the hierarchy.
 1. If that type implements the given method, then use that implementation.
 2. Otherwise, move up to the parent type and see if there's an implementation there.
 - a. If there is an implementation, use that.
 - b. Otherwise, repeat step 2 until an implementation is found.

Exercise

- ▶ Do questions 5 through 7 from Quiz.
- ▶ Please hand them in when done and then start reading the BallWorlds specification on your schedule page.



Q5-7, hand in when done, then start reading BallWorlds spec

Determining Method at Runtime

- ▶ Step 1: Identify the Declared/Casted Type
 - DeclaredType var = (can change!)
 - CastedType var2 = (CastedType)var;
- ▶ Step 2: Identify the Instantiation/Actual Type
 - (Never changes! To the right of original “= new *”)
 - ...= new InstantiatedType();
- ▶ Step 3: Check for Compilation Errors
 - Method not available based on declared/casted type
 - Incompatible type assignment: Dog x = new Cat()
 - Invalid cast: casting to type not below declaration type
- ▶ Step 4: Check for Runtime Errors
 - Instantiation type must matches casted type OR
 - Casted type is between declaration and instantiation type
- ▶ Step 5: Find Method to Run
 - Start with instantiation type and look to super class!

BallWorlds Worktime

»» Pulsar, Mover, etc.