CS 535 Object-Oriented Programming & Design
Spring Semester, 1999
Doc 4 Polymorphism
Contents

References

Designing Object-Oriented Software, Wirfs-Brock, Wilkerson, Wiener, Chapter 2

Design Patterns: Elements of Object-Oriented Software, Gamma, Helm, Johnson, Vlissides, 1995

Reading

Designing Object-Oriented Software, Wirfs-Brock, Wilkerson, Wiener, Chapter 2

Polymorphism

Objects with the same interface can be substituted for each other at run-time

Objects will behave according to their type

In C++ polymorphism requires
- Inheritance
- Pointers
- Virtual functions

In Java polymorphism requires
- Inheritance or
- Interfaces

In Smalltalk polymorphism does not require inheritance

Java Inheritance Example

```
public class Parent{
   public void foo() {
      System.out.println( "Parent foo" );
      bar();
   }

   public void bar(){
      System.out.println( "Parent bar" );
   }
}

public class ChildFoo extends Parent{
   public void foo(){
      System.out.println( "ChildFoo foo" );
      bar();
   }
}

public class ChildBar extends Parent{
   public void bar(){
      System.out.println( "ChildBar bar" );
   }
}
```

What is the Output Here?

```
public  class Test {
   public static void main(String[] args)  {
      Parent test = new Parent();
      test.foo();
      test = new ChildFoo();
      test.foo();
      test = new ChildBar();
      test.foo();
   }
}
```

Java Interface Example

```
public interface Parent{
   public void foo();
   public void bar();
}

public class ChildFoo implements Parent{
   public void foo(){
      System.out.println( "ChildFoo foo" );
      bar();
   }
   public void bar(){
      System.out.println( "ChildFoo bar" );
   }
}

public class ChildBar implements Parent{
   public void foo(){
      System.out.println( "ChildBar foo" );
      bar();
   }
   public void bar(){
      System.out.println( "ChildBar bar" );
   }
}
```

What is the Output Here?

```
public  class Test{
   public static void main(String[] args) {
      Parent test = new ChildFoo();
      test.foo();
      test = new ChildBar();
      test.foo();
      }
   }
```

Polymorphism and C++

See http://www.eli.sdsu.edu/courses/fall95/cs596_1/notes/Poly/Poly.html for a more complete example of polymorphism and C++

```
#include <iostream.h>

class  Parent {
public:
   void virtual foo();
   void virtual bar();
};

void Parent::foo() {
   cout << "Parent foo" << endl;
   bar();
}

void Parent::bar() { cout << "Parent bar" << endl; }

class ChildFoo : public Parent {
   void virtual foo();
};

void ChildFoo::foo() {
   cout << "ChildFoo foo" << endl;
   bar();
}

class ChildBar : public Parent {
   void virtual bar();
};

void ChildBar::bar() { cout << "ChildBar bar" << endl; }
```

Virtual + Pointers

```
int main() {
   Parent*  test = new Parent;
   test->foo();
   test = new ChildFoo;
   test->foo();
   test = new ChildBar;
   test->foo();
}
```

Output

```
Parent foo
Parent bar
ChildFoo foo
Parent bar
Parent foo
ChildBar bar
```

Just Virtual

```
int main() {
   Parent  test;
   test.foo();
   ChildFoo child;
   test = child;
   test.foo();
}
```

Output

```
Parent foo
Parent bar
Parent foo
Parent bar
```

C++ without Virtual Functions

```
#include <iostream.h>

class  Parent {
public:
   void foo();
   void bar();
};

void Parent::foo() {
   cout << "Parent foo" << endl;
   bar();
}

void Parent::bar() { cout << "Parent bar" << endl; }

class ChildFoo : public Parent {
public:
   void virtual foo();
};

void ChildFoo::foo() {
   cout << "ChildFoo foo" << endl;
   bar();
}

class ChildBar : public Parent {
   void virtual bar();
};

void ChildBar::bar() { cout << "ChildBar bar" << endl; }
```

Pointers but not Virtual

```
int main() {
   Parent*  test = new Parent;
   test->foo();
   test = new ChildFoo;
   test->foo();
   test = new ChildBar;
   test->foo();
   ChildFoo child;
   child.foo();
}
```

Output

```
Parent foo
Parent bar
Parent foo
Parent bar
Parent foo
Parent bar
ChildFoo foo
Parent bar
```

Simplistic Example

Last Federal Virtual Bank wants its entire banking software redone in Java, so it can shut down its branch offices and perform all its business via the WWW.

Customer records include the customers name, address, personal information, passwords, etc. and accounts.

The bank offers various types of accounts: checking, savings, CD, Junior savings accounts.

Bank officers will introduce new types of accounts from time to time.

Checking account charge 12 cents/check unless the average account balance for the month is greater than $1,000. The first three ATM transactions per month are free. Additional ATM transactions cost 50 cents.

All transactions over $1,000 dollars must be reported to the federal government.

Junior savings accounts are for children under the age of 13. Children can deposit any amount into the account. Deposits of over $100 are reported to their parents. Children can withdrawal up to $10 from the account. Individual withdrawals over $10 must be verified by a parent. Total withdrawals over $100 per month are reported to the parents.

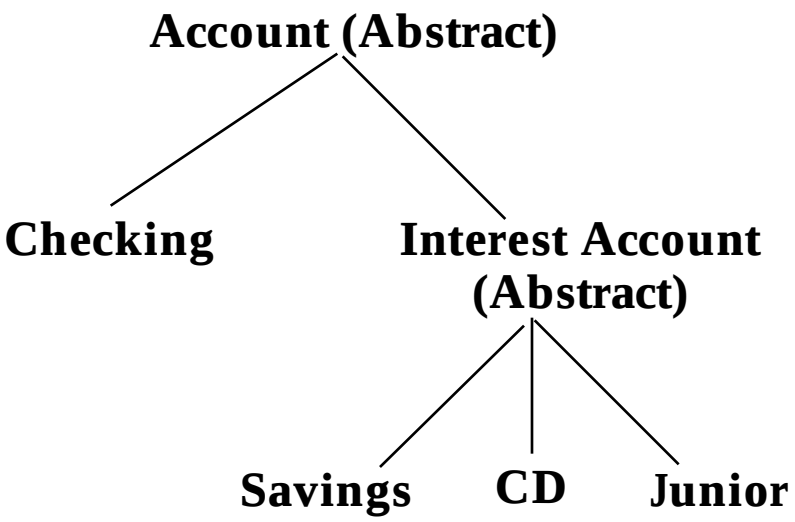
Transactions include time & date, amount, location, type of transaction, account number and teller.

Banking Classes

Customer

Transaction

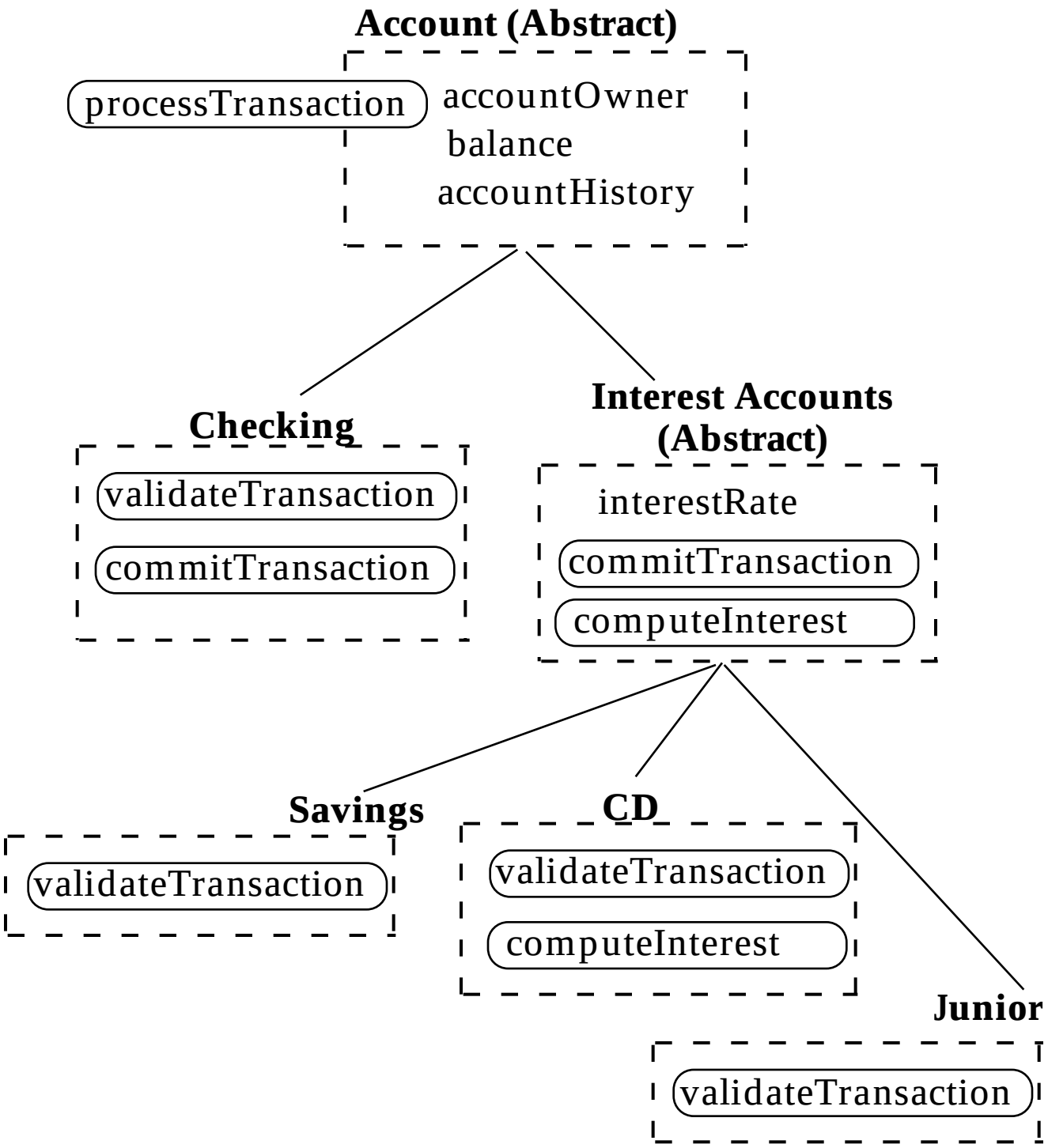
Currency



Account

```
abstract class account {

   public static final boolean VALID = true;

   protected Customer accountOwner;
   protected Currency      balance;
   protected Stack accountHistory;

   // Other fields left out

   public void processTransaction( Transaction accountActivity ) {

      if ( validateTransaction( accountActivity ) == VALID )

         commitTransaction( accountActivity );

      else

         // report the problem. Code not shown
   }


   protected abstract boolean validateTransaction( Transaction
                                                   accountActivity
                                                  );

   protected abstract void commitTransaction( Transaction
                                              accountActivity
                                             );

   // other methods left out
}
```

Account Class Inheritance



Polymorphism

```
Account  newCustomer;

newCustomer = magicFunctionToCreateNewAccount()

newCustomer.processTransaction( amount );
```

Which processTransaction is called?

Adding new types of accounts to program requires:

- Adding new subclasses
- Changing code that creates objects

Modular Design Rule

Avoid Case (and if) Statements

```
switch  (  newCustomer.accountType ) {

   case SAVINGS:
      // Code to process Savings account

   case CD:
      // Code to process CD account

   case CHECKING:
      // Code to process Checking account

   // etc.
}
```

Use Polymorphism

```
newCustomer.processTransaction( amount );
```

Supports:

Composability Continuity