**Lab Exercises**

Class: Name: StuID:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: Score:

**Lab Exercise 1 — Account Hierarchy**

**I Lab Objectives**

In this lab, you will practice:

1. Using inheritance to create an account hierarchy that includes an Account class, a SavingsAccount class and a CheckingAccount class.
2. Using private data members to limit access to data members.
3. Redefining base-class member functions in a derived class.

**II Description of the Problem(译文见教材P387 11.10)**

Create an inheritance hierarchy that a bank might use to represent customers’ bank accounts. All customers at this bank can deposit (i.e., credit) money into their accounts and withdraw (i.e., debit) money from their accounts. More specific types of accounts also exist. Savings accounts, for instance, earn interest on the money they hold. Checking accounts, on the other hand, charge a fee per transaction (i.e., credit or debit).

Create an inheritance hierarchy containing base class Account and derived classes SavingsAccount and CheckingAccount that inherit from class Account. Base class Account should include one data member of type double to represent the account balance. The class should provide a constructor that receives an initial balance and uses it to initialize the data member. The constructor should validate the initial balance to ensure that it is greater than or equal to 0.0. If not, the balance should be set to 0.0 and the constructor should display an error message, indicating that the initial balance was invalid. The class should provide three member functions. Member function credit should add an amount to the current balance. Member function debit should withdraw money from the Account and ensure that the debit amount does not exceed the Account’s balance. If it does, the balance should be left unchanged and the function should print the message "Debit amount exceeded account balance." Member function getBalance should return the current balance.

Derived class SavingsAccount should inherit the functionality of an Account, but also include a data member of type double indicating the interest rate (percentage) assigned to the Account. SavingsAccount’s constructor should receive the initial balance, as well as an initial value for the SavingsAccount’s interest rate. SavingsAccount should provide a public member function calculateInterest that returns a double indicating the amount of interest earned by an account. Member function calculateInterest should determine this amount by multiplying the interest rate by the account balance. [Note: SavingsAccount should inherit member functions credit and debit as is without redefining them.]

Derived class CheckingAccount should inherit from base class Account and include an additional data member of type double that represents the fee charged per transaction. CheckingAccount’s constructor should receive the initial balance, as well as a parameter indicating a fee amount. Class CheckingAccount should redefine member functions credit and debit so that they subtract the fee from the account balance whenever either transaction is performed successfully. CheckingAccount’s versions of these functions should invoke the base-class Account version to perform the updates to an account balance. CheckingAccount’s debit function should charge a fee only if money is actually withdrawn (i.e., the debit amount does not exceed the account balance). [*Hint*: Define Account’s debit function so that it returns a bool indicating whether money was withdrawn. Then use the return value to determine whether a fee should be charged.]

After defining the classes in this hierarchy, write a program that creates objects of each class and tests their member functions. Add interest to the SavingsAccount object by first invoking its calculateInterest function, then passing the returned interest amount to the object’s credit function.

**III Sample Output**



**IV Problem-Solving Tips**

1. Each derived class constructor, SavingsAccount and CheckingAccount, should call the Account constructor explicitly.
2. Do not use the debit member function inside the chargeFee member function, because the debit member function would then call the chargeFee member function, leading to infinite recursion. Instead use the inherited *get* and *set* functions for the account balance.

**V Your Solution**

// Lab 1: Account.h

// Definition of Account class.

#ifndef ACCOUNT\_H

#define ACCOUNT\_H

**class** Account

{

**public**:

Account( **double** ); // constructor initializes balance

**void** credit( **double** ); // add an amount to the account balance

**bool** debit( **double** ); // subtract an amount from the account balance

**void** setBalance( **double** ); // sets the account balance

**double** getBalance(); // return the account balance

**private**:

**double** balance; // data member that stores the balance

}; // end class Account

#endif

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// Lab 1: Account.cpp

// Member-function definitions for class Account.

#include <iostream>

**using** **namespace** std;

#include "Account.h" // include definition of class Account

// Account constructor initializes data member balance

Account::Account( **double** initialBalance )

{

// if initialBalance is greater than or equal to 0.0, set this value

// as the balance of the Account

**if** ( initialBalance >= 0.0 )

balance = initialBalance;

**else** // otherwise, output message and set balance to 0.0

{

cout << "Error: Initial balance cannot be negative." << endl;

balance = 0.0;

} // end if...else

} // end Account constructor

// credit (add) an amount to the account balance

**void** Account::credit( **double** amount )

{

balance = balance + amount; // add amount to balance

} // end function credit

// debit (subtract) an amount from the account balance

// return bool indicating whether money was debited

**bool** Account::debit( **double** amount )

{

**if** ( amount > balance ) // debit amount exceeds balance

{

cout << "Debit amount exceeded account balance." << endl;

**return** **false**;

} // end if

**else** // debit amount does not exceed balance

{

balance = balance - amount;

**return** **true**;

} // end else

} // end function debit

// set the account balance

**void** Account::setBalance( **double** newBalance )

{

balance = newBalance;

} // end function setBalance

// return the account balance

**double** Account::getBalance()

{

**return** balance;

} // end function getBalance

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// Lab 1: CheckingAccount.h

// Definition of CheckingAccount class.

#ifndef CHECKING\_H

#define CHECKING\_H

/\* Write a directive to include the Account header file \*/

#include "Account.h"

/\* Write a line to have class CheckingAccount inherit publicly from Account \*/

**class** CheckingAccount :**public** Account

{

**public**:

// constructor initializes balance and transaction fee

/\* Declare a two-argument constructor for CheckingAccount \*/

CheckingAccount(**double**,**double**);

/\* Redeclare member function credit, which will be redefined \*/

**void** credit(**double**);

/\* Redeclare member function debit, which will be redefined \*/

**bool** debit(**double**);

**private**:

/\* Declare data member transactionFee \*/

**double** transactionFee;

// utility function to charge fee

/\* Declare member function chargeFee \*/

**void** chargeFee();

}; // end class CheckingAccount

#endif

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// Lab 1: CheckingAccount.cpp

// Member-function definitions for class CheckingAccount.

#include <iostream>

**using** **namespace** std;

#include <iomanip>

#include "CheckingAccount.h" // CheckingAccount class definition

// constructor initializes balance and transaction fee

/\* Write the CheckingAccount constructor to call the Account constructor

and validate and set the transaction fee value \*/

CheckingAccount::CheckingAccount(**double** x,**double** y)

:Account(x),transactionFee(y)

{

}

// credit (add) an amount to the account balance and charge fee

/\* Write the credit member function to call Account's credit function

and then charge a fee \*/

**void** CheckingAccount::credit(**double** x){

Account::credit(x);

chargeFee();

}

// debit (subtract) an amount from the account balance and charge fee

/\* Write the debit member function to call Account's debit function

and then charge a fee if it returned true\*/

**bool** CheckingAccount::debit(**double** x){

**if**(Account::debit(x)){

chargeFee();

**return** **true**;

}**else** **return** **false**;

}

// subtract transaction fee

/\* Write the chargeFee member function to subtract transactionFee

from the current balance and display a message \*/

**void** CheckingAccount::chargeFee(){

**if**(Account::debit(transactionFee))

cout<<"$"<<fixed<<setprecision(2)<<transactionFee<<" transaction fee charged"<<endl;**else** **return**;

}

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// Lab 1: SavingsAccount.h

// Definition of SavingsAccount class.

#ifndef SAVINGS\_H

#define SAVINGS\_H

/\* Write a directive to include the Account header file \*/

#include "Account.h"

/\* Write a line to have class SavingsAccount inherit publicly from Account \*/

**class** SavingsAccount:**public** Account{

**public**:

// constructor initializes balance and interest rate

/\* Declare a two-parameter constructor for SavingsAccount \*/

SavingsAccount(**double**,**double**);

/\* Declare member function calculateInterest \*/

**double** calculateInterest();

**private**:

/\* Declare data member interestRate \*/

**double** interestRate;

}; // end class SavingsAccount

#endif

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// Lab 1: SavingsAccount.cpp

// Member-function definitions for class SavingsAccount.

#include "SavingsAccount.h" // SavingsAccount class definition

// constructor initializes balance and interest rate

/\* Write the SavingsAccount constructor to call the Account constructor

and validate and set the interest rate value \*/

SavingsAccount::SavingsAccount(**double** x,**double** y)

:Account(x),interestRate(y){

}

// return the amount of interest earned

/\* Write the calculateInterest member function to return the

interest based on the current balance and interest rate \*/

**double** SavingsAccount::calculateInterest(){

**double** x=getBalance()\*interestRate;

**return** x;

}

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// Lab 1: bankAccounts.cpp

// Test program for Account hierarchy.

#include <iostream>

#include <iomanip>

**using** **namespace** std;

#include "Account.h" // Account class definition

#include "SavingsAccount.h" // SavingsAccount class definition

#include "CheckingAccount.h" // CheckingAccount class definition

**int** main()

{

Account account1( 50.0 ); // create Account object

SavingsAccount account2( 25.0, .03 ); // create SavingsAccount object

CheckingAccount account3( 80.0, 1.0 ); // create CheckingAccount object

cout << fixed << setprecision( 2 );

// display initial balance of each object

cout << "account1 balance: $" << account1.getBalance() << endl;

cout << "account2 balance: $" << account2.getBalance() << endl;

cout << "account3 balance: $" << account3.getBalance() << endl;

cout << "\nAttempting to debit $25.00 from account1." << endl;

account1.debit( 25.0 ); // try to debit $25.00 from account1

cout << "\nAttempting to debit $30.00 from account2." << endl;

account2.debit( 30.0 ); // try to debit $30.00 from account2

cout << "\nAttempting to debit $40.00 from account3." << endl;

account3.debit( 40.0 ); // try to debit $40.00 from account3

// display balances

cout << "\naccount1 balance: $" << account1.getBalance() << endl;

cout << "account2 balance: $" << account2.getBalance() << endl;

cout << "account3 balance: $" << account3.getBalance() << endl;

cout << "\nCrediting $40.00 to account1." << endl;

account1.credit( 40.0 ); // credit $40.00 to account1

cout << "\nCrediting $65.00 to account2." << endl;

account2.credit( 65.0 ); // credit $65.00 to account2

cout << "\nCrediting $20.00 to account3." << endl;

account3.credit( 20.0 ); // credit $20.00 to account3

// display balances

cout << "\naccount1 balance: $" << account1.getBalance() << endl;

cout << "account2 balance: $" << account2.getBalance() << endl;

cout << "account3 balance: $" << account3.getBalance() << endl;

// add interest to SavingsAccount object account2

/\* Declare a variable interestEarned and assign it the interest

account2 should earn \*/

**double** interestEarned=account2.calculateInterest();

cout << "\nAdding $" << interestEarned << " interest to account2."

<< endl;

/\* Write a statement to credit the interest to account2's balance \*/

account2.credit(interestEarned);

cout << "\nNew account2 balance: $" << account2.getBalance() << endl;

} // end main

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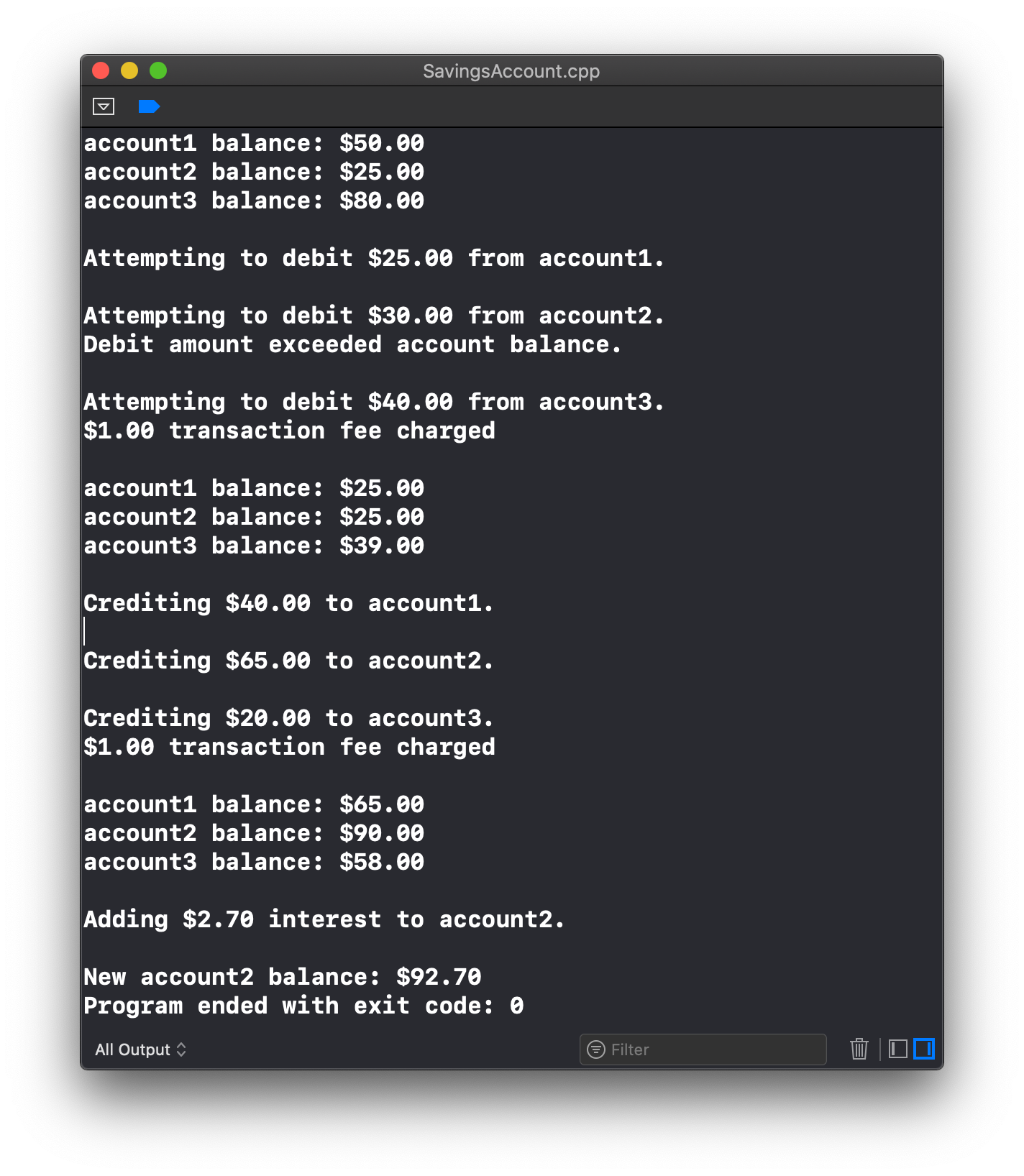
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**Lab Exercise 2 — Composition**

**I Lab Objectives**

In this lab, you will practice:

1. Using composition to incorporate one class’s members into another class.

The follow-up question and activity also will give you practice:

1. Comparing inheritance and composition.

**II Description of the Problem (译文见P386 11.3)**

Many programs written with inheritance could be written with composition instead, and vice versa. Rewrite class BasePlusCommissionEmployee of the CommissionEmploy ee–BasePlusCommissionEmployee hierarchy to use composition rather than inheritance.

**III Sample Output**



**IV Problem-Solving Tips**

1. To implement BasePlusCommissionEmployee using composition, include a ComissionEmployee object as a data member in the BasePlusCommission Employee class.
2. To access a member of CommissionEmployee inside a member function of BasePlusCommissionEmployee, it must be preceded by the name of the CommissionEmployee object and the dot operator.
3. Most of BasePlusCommissionEmployee’s member functions will be implemented by simply calling the same member function from the CommissionEmployee object; this is known as “delegation.”

**V Your Solution**

// Lab 2: CommissionEmployee.h

// CommissionEmployee class definition represents a commission employee.

#ifndef COMMISSION\_H

#define COMMISSION\_H

#include <string> // C++ standard string class

**using** **namespace** std;

**class** CommissionEmployee

{

**public**:

CommissionEmployee( **const** string &, **const** string &, **const** string &,

**double** = 0.0, **double** = 0.0 );

**void** setFirstName( **const** string & ); // set first name

string getFirstName() **const**; // return first name

**void** setLastName( **const** string & ); // set last name

string getLastName() **const**; // return last name

**void** setSocialSecurityNumber( **const** string & ); // set SSN

string getSocialSecurityNumber() **const**; // return SSN

**void** setGrossSales( **double** ); // set gross sales amount

**double** getGrossSales() **const**; // return gross sales amount

**void** setCommissionRate( **double** ); // set commission rate (percentage)

**double** getCommissionRate() **const**; // return commission rate

**double** earnings() **const**; // calculate earnings

**void** print() **const**; // print CommissionEmployee object

**private**:

string firstName;

string lastName;

string socialSecurityNumber;

**double** grossSales; // gross weekly sales

**double** commissionRate; // commission percentage

}; // end class CommissionEmployee

#endif

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// Lab 2: CommissionEmployee.cpp

// Class CommissionEmployee member-function definitions.

#include <iostream>

**using** **namespace** std;

#include "CommissionEmployee.h" // CommissionEmployee class definition

// constructor

CommissionEmployee::CommissionEmployee(

**const** string &first, **const** string &last, **const** string &ssn,

**double** sales, **double** rate )

{

firstName = first; // should validate

lastName = last; // should validate

socialSecurityNumber = ssn; // should validate

setGrossSales( sales ); // validate and store gross sales

setCommissionRate( rate ); // validate and store commission rate

} // end CommissionEmployee constructor

// set first name

**void** CommissionEmployee::setFirstName( **const** string &first )

{

firstName = first; // should validate

} // end function setFirstName

// return first name

string CommissionEmployee::getFirstName() **const**

{

**return** firstName;

} // end function getFirstName

// set last name

**void** CommissionEmployee::setLastName( **const** string &last )

{

lastName = last; // should validate

} // end function setLastName

// return last name

string CommissionEmployee::getLastName() **const**

{

**return** lastName;

} // end function getLastName

// set social security number

**void** CommissionEmployee::setSocialSecurityNumber( **const** string &ssn )

{

socialSecurityNumber = ssn; // should validate

} // end function setSocialSecurityNumber

// return social security number

string CommissionEmployee::getSocialSecurityNumber() **const**

{

**return** socialSecurityNumber;

} // end function getSocialSecurityNumber

// set gross sales amount

**void** CommissionEmployee::setGrossSales( **double** sales )

{

grossSales = ( sales < 0.0 ) ? 0.0 : sales;

} // end function setGrossSales

// return gross sales amount

**double** CommissionEmployee::getGrossSales() **const**

{

**return** grossSales;

} // end function getGrossSales

// set commission rate

**void** CommissionEmployee::setCommissionRate( **double** rate )

{

commissionRate = ( rate > 0.0 && rate < 1.0 ) ? rate : 0.0;

} // end function setCommissionRate

// return commission rate

**double** CommissionEmployee::getCommissionRate() **const**

{

**return** commissionRate;

} // end function getCommissionRate

// calculate earnings

**double** CommissionEmployee::earnings() **const**

{

**return** commissionRate \* grossSales;

} // end function earnings

// print CommissionEmployee object

**void** CommissionEmployee::print() **const**

{

cout << "commission employee: " << firstName << ' ' << lastName

<< "\nsocial security number: " << socialSecurityNumber

<< "\ngross sales: " << grossSales

<< "\ncommission rate: " << commissionRate;

} // end function print

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// Lab 2: BasePlusCommissionEmployee.h

// BasePlusCommissionEmployee class using composition.

#ifndef BASEPLUS\_H

#define BASEPLUS\_H

#include <string> // C++ standard string class

**using** **namespace** std;

#include "CommissionEmployee.h" // CommissionEmployee class definition

**class** BasePlusCommissionEmployee

{

**public**:

BasePlusCommissionEmployee( **const** string &, **const** string &,

**const** string &, **double** = 0.0, **double** = 0.0, **double** = 0.0 );

**void** setFirstName( **const** string & ); // set first name

string getFirstName() **const**; // return first name

**void** setLastName( **const** string & ); // set last name

string getLastName() **const**; // return last name

**void** setSocialSecurityNumber( **const** string & ); // set SSN

string getSocialSecurityNumber() **const**; // return SSN

**void** setGrossSales( **double** ); // set gross sales amount

**double** getGrossSales() **const**; // return gross sales amount

**void** setCommissionRate( **double** ); // set commission rate

**double** getCommissionRate() **const**; // return commission rate

**void** setBaseSalary( **double** ); // set base salary

**double** getBaseSalary() **const**; // return base salary

**double** earnings() **const**; // calculate earnings

**void** print() **const**; // print BasePlusCommissionEmployee object

**private**:

**double** baseSalary; // base salary

/\* Write a declaration for a CommissionEmployee

data member \*/

CommissionEmployee iii;

}; // end class BasePlusCommissionEmployee

#endif

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// Lab 2: BasePlusCommissionEmployee.cpp

// Member-function definitions of class BasePlusCommissionEmployee

// using composition.

#include <iostream>

**using** **namespace** std;

// BasePlusCommissionEmployee class definition

#include "BasePlusCommissionEmployee.h"

// constructor

BasePlusCommissionEmployee::BasePlusCommissionEmployee(

**const** string &first, **const** string &last, **const** string &ssn,

**double** sales, **double** rate, **double** salary )

// initialize composed object

:iii(first,last,ssn,sales,rate) /\* Initialize the commissionEmployee data member,

pass (first, last, ssn, sales, rate) to its constructor \*/

{

setBaseSalary( salary ); // validate and store base salary

} // end BasePlusCommissionEmployee constructor

// set commission employee's first name

**void** BasePlusCommissionEmployee::setFirstName( **const** string &first )

{

/\* Call commissionEmployee's setFirstName function \*/

iii.setFirstName(first);

} // end function setFirstName

// return commission employee's first name

string BasePlusCommissionEmployee::getFirstName() **const**

{

/\* Call commissionEmployee's getFirstName function \*/

**return** iii.getFirstName();

} // end function getFirstName

// set commission employee's last name

**void** BasePlusCommissionEmployee::setLastName( **const** string &last )

{

/\* Call commissionEmployee's setLastName function \*/

iii.setLastName(last);

} // end function setLastName

// return commission employee's last name

string BasePlusCommissionEmployee::getLastName() **const**

{

/\* Call commissionEmployee's getLastName function \*/

**return** iii.getLastName();

} // end function getLastName

// set commission employee's social security number

**void** BasePlusCommissionEmployee::setSocialSecurityNumber(

**const** string &ssn )

{

/\* Call commissionEmployee's setSocialSecurity function \*/

iii.setSocialSecurityNumber(ssn);

} // end function setSocialSecurityNumber

// return commission employee's social security number

string BasePlusCommissionEmployee::getSocialSecurityNumber() **const**

{

/\* Call commissionEmployee's getSocialSecurity function \*/

**return** iii.getSocialSecurityNumber();

} // end function getSocialSecurityNumber

// set commission employee's gross sales amount

**void** BasePlusCommissionEmployee::setGrossSales( **double** sales )

{

/\* Call commissionEmployee's setGrossSales function \*/

iii.setGrossSales(sales);

} // end function setGrossSales

// return commission employee's gross sales amount

**double** BasePlusCommissionEmployee::getGrossSales() **const**

{

/\* Call commissionEmployee's getGrossSales function \*/

**return** iii.getGrossSales();

} // end function getGrossSales

// set commission employee's commission rate

**void** BasePlusCommissionEmployee::setCommissionRate( **double** rate )

{

/\* Call commissionEmployee's setCommissionRate function \*/

iii.setCommissionRate(rate);

} // end function setCommissionRate

// return commission employee's commission rate

**double** BasePlusCommissionEmployee::getCommissionRate() **const**

{

/\* Call commissionEmployee's getCommissionRate function \*/

**return** iii.getCommissionRate();

} // end function getCommissionRate

// set base salary

**void** BasePlusCommissionEmployee::setBaseSalary( **double** salary )

{

baseSalary = ( salary < 0.0 ) ? 0.0 : salary;

} // end function setBaseSalary

// return base salary

**double** BasePlusCommissionEmployee::getBaseSalary() **const**

{

**return** baseSalary;

} // end function getBaseSalary

// calculate earnings

**double** BasePlusCommissionEmployee::earnings() **const**

{

**return** getBaseSalary() +iii.earnings()

/\* Call commissionEmployee's earnings function \*/;

} // end function earnings

// print BasePlusCommissionEmployee object

**void** BasePlusCommissionEmployee::print() **const**

{

cout << "base-salaried ";

// invoke composed CommissionEmployee object's print function

/\* Call commissionEmployee's print function \*/

iii.print();

cout << "\nbase salary: " << getBaseSalary();

} // end function print

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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// Lab 2: composition.cpp

// Testing class BasePlusCommissionEmployee.

#include <iostream>

#include <iomanip>

**using** **namespace** std;

// BasePlusCommissionEmployee class definition

#include "BasePlusCommissionEmployee.h"

**int** main()

{

// instantiate BasePlusCommissionEmployee object

BasePlusCommissionEmployee

employee( "Bob", "Lewis", "333-33-3333", 5000, .04, 300 );

// set floating-point output formatting

cout << fixed << setprecision( 2 );

// get commission employee data

cout << "Employee information obtained by get functions: \n"

<< "\nFirst name is " << employee.getFirstName()

<< "\nLast name is " << employee.getLastName()

<< "\nSocial security number is "

<< employee.getSocialSecurityNumber()

<< "\nGross sales is " << employee.getGrossSales()

<< "\nCommission rate is " << employee.getCommissionRate()

<< "\nBase salary is " << employee.getBaseSalary() << endl;

employee.setBaseSalary( 1000 ); // set base salary

cout << "\nUpdated employee information output by print function: \n"

<< endl;

employee.print(); // display the new employee information

// display the employee's earnings

cout << "\n\nEmployee's earnings: $" << employee.earnings() << endl;

} // end main

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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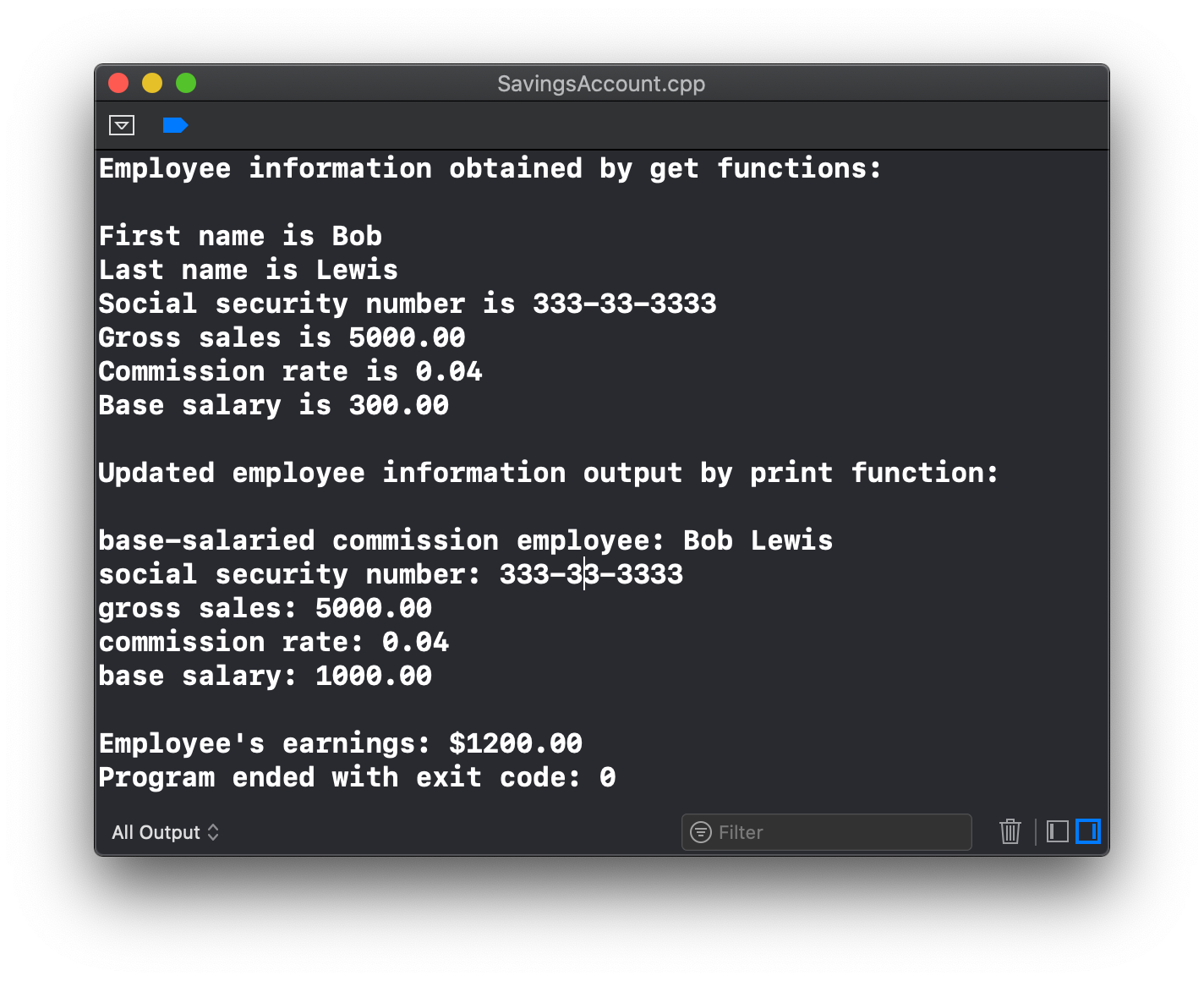
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**VI Follow-Up Questions and Activities**

1. Assess the relative merits of the two approaches for designing classes Commission-Employee and BasePlusCommissionEmployee, as well as for object-oriented programs in general. Which approach is more natural? Why?