Theoretical Exercise - Problem #3

Distribution of work
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0 - Problem Description

ET.02.04 Tercer Problema

Write and test a method to determine what type of bank account can be offered to a potential young customer (the method will accept an object of type customer with as many attributes as necessary - use the set and get methods). The decision is made according to certain business rules that our marketing department, using the most powerful ML/IA techniques, has established.

1) If the potential customer is a minor, he or she is studying, and he or she is usually lives at home with his/her parents, the type of product to be offered will be the "*Comfort" Account*.
2) If the potential customer is under 25 years of age and he or she is still enrolled in any course at the university, but he or she is away from the family home, he or she will be offered the "*Come on, you can*" account.
3) If the potential customer is of legal age, and if he or she has started working, but still lives with his/her parents, he/she will be offered the "*Save Now While You Can*" account; on the other hand, if he or she does not longer live with his/her parents, he or she will be offered the "*Jump out of the Nest*" Account.
4) If the potential customer is over 25 years old, and he or she is working, but he or she still lives with his/her parents, he or she will be offered the "*Become independent, it's about time*" account.
5) If the potential customer is over 25 years of age, and he or she is working and no longer living in the family home, he or she will be offered the "*Welcome to Adult Life*" Account.

It is assumed that there can be no ambiguities in the type of account that can be offered to a given client. If you find them, write down the assumptions and exceptions that you consider most appropriate.

1- Write, at least the pseudocode of the identified method.

```
import java.time.LocalDate;

class BirthDate {

   private int year, month, day;

   public BirthDate(int year, int month, int day) {
       setYear(year);
       setMonth(month);
       setDay(day);
   }

   public int getAge() {
       int currentYear = LocalDate.now().getYear();
       int currentMonth = LocalDate.now().getMonth().getValue();
       int currentDay = LocalDate.now().getDayOfMonth();

       // Birthday of person within the current year already over
       if (getMonth() > currentMonth ||
       getMonth() == currentMonth && getDay() >= currentDay) {
           return currentYear - getYear();
       }

       // Birthday of person within the current year not yet over
       else
           return currentYear - getYear() - 1;
   }

   public void setYear(int year) {
       if (year >= 1800 && year <= LocalDate.now().getYear())
           this.year = year;
       else
           throw new IllegalArgumentException("Illegal value");
   }

   public void setMonth(int month) {
       if (month >= 1 && month <= 12)
           this.month = month;
       else
           throw new IllegalArgumentException("Illegal value");
   }

   public void setDay(int day) {
       if (day >= 1 && day <= 31)
           this.day = day;
       else
           throw new IllegalArgumentException("Illegal value");
   }

   public int getYear() {
       return year;

   }
   public int getMonth() {
       return month;
   }

   public int getDay() {
       return day;
   }
}
```

```
class Customer {
   // as many attributes as possible
   private BirthDate birthDate;
   private boolean isStudent;
   private boolean isWorking;
   private boolean permanentResidencyWithParents;

   public Customer(BirthDate birthDate, boolean isStudent, boolean isWorking, boolean
permanentResidencyWithParents) {
       setBirthDate(birthDate);
       setStudent(isStudent);
       setWorking(isWorking);
       setPermanentResidencyWithParents(permanentResidencyWithParents);
   }

   public void setBirthDate(BirthDate birthDate) {
       if (birthDate == null)
           throw new IllegalArgumentException("Argument needs to be initialized");

       this.birthDate = birthDate;
   }

   public void setStudent(boolean student) {
       isStudent = student;
   }

   public void setWorking(boolean working) {
       isWorking = working;
   }

   public void setPermanentResidencyWithParents(boolean permanentResidencyWithParents) {
       this.permanentResidencyWithParents = permanentResidencyWithParents;
   }

   public boolean isStudent() {
       return isStudent;
   }

   public boolean isWorking() {
       return isWorking;
   }

   public boolean isPermanentResidencyWithParents() {
       return permanentResidencyWithParents;
   }

   public BirthDate getBirthDate() {
       return birthDate;
   }
}
```

```
enum BankAccountType {
   Comfort, ComeOnYouCan, SaveNowWhileYouCan, JumpOutOfTheNest,
   BecomeIndependentItsAboutTime, WelcomeToAdultLife
}
```

```
public class BankLogic {

   public static BankAccountType determineAccountTypeYoungCustomer(Customer c) {
       // (1) is minor, studying, residency with parents -> Comfort account
       if (c.getBirthDate().getAge() < 18 &&
               c.isStudent() &&
               c.isPermanentResidencyWithParents())
           return BankAccountType.Comfort;


       // (2) under 25, studying, residency not with parents -> ComeOnYouCan account
       else if (c.getBirthDate().getAge() < 25 &&
               c.isStudent() &&
               !c.isPermanentResidencyWithParents())
           return BankAccountType.ComeOnYouCan;

       // (3.1) 18 and above, working, residency with parents -> SaveNowWhileYouCan account
       else if (c.getBirthDate().getAge() >= 18 &&
               c.getBirthDate().getAge() < 25 &&
               c.isWorking() &&
               c.isPermanentResidencyWithParents())
           return BankAccountType.SaveNowWhileYouCan;

       // (3.2) 18 and above, working, residency not with parents -> SaveNowWhileYouCan account
       else if (c.getBirthDate().getAge() >= 18 &&
               c.getBirthDate().getAge() < 25 &&
               c.isWorking() &&
               !c.isPermanentResidencyWithParents())
           return BankAccountType.JumpOutOfTheNest;0

       // (4) 25 and above, working, residency with parents -> BecomeIndependentItsAboutTime account
       else if (c.getBirthDate().getAge() >= 25 &&
               c.isWorking() &&
               c.isPermanentResidencyWithParents())
           return BankAccountType.BecomeIndependentItsAboutTime;

       // (5) 25 and above, working, residency not with parents -> WelcomeToAdultLife account
       else if (c.getBirthDate().getAge() >= 25 &&
               c.isWorking() &&
               !c.isPermanentResidencyWithParents())
           return BankAccountType.WelcomeToAdultLife;

       // This code is only executed, if the customer is NOT applicable for a Young Account
       throw new IllegalArgumentException("Account is not applicable for a young account.");
   }

}
```

2 - Identify the variables that must be considered to test the method.
In this problem we have our result with 4 inputs, one of them being a number (integer) and the other three are a true or false statement (boolean).

c.getBirthDate().getAge() : int
c.isStudent() : boolean
c.isPermanentResidencyWithParents() : boolean
c.isWorking() : boolean

These input variables are going to be the main focus of our testing and are found in the BankLogic class.

3 - Identify the test values for each one of the variables previously identified, specifying the technique used to obtain each of those values).

Parameter	Equivalence Class	Values for equivalence class	Boundary values (heavy variant)	Error guessing values
c.getBirthDate() .getAge()	(-∞,0) [0,18) [18,25) [25,+∞)	-8, 5, 20, 40	-1, 0, 1, 17, 18, 19, 24, 25, 26	-1000 1000
c.isStudent()	True/False	True/False	-	-
c.isPermanentR esidencyWithPa rents()	True/False	True/False	-	-
c.isWorking()	True/False	True/False	-	-

4 - Calculate the maximum possible number of test cases that could be generated from the test values.

In order to calculate the maximum number of test cases, we consider that an input to this problem (c.getBirthDate().getAge()), is the only one needed in this decision. Because it is the only one that can really change. So we are going to consider the following values: (-1, 0, 1, 17, 18, 19, 24, 25, 26, -1000, 1000).

So the possible amount of combinations is: 11 * 2 * 2 * 2 = 88.

5 - Define some test suites using each use

In this step we want to check if every operation works, if the person who wants the account is valid and if it is the type of the account.

Test suit	Variables
1	c.getBirthDate().getAge() = 17 c.isStudent() = true c.isPermanentResidencyWithParents() = true c.isWorking() = false
2	c.getBirthDate().getAge() = 19 c.isStudent() = true c.isPermanentResidencyWithParents() = false c.isWorking() = false
3	c.getBirthDate().getAge() = 19 c.isStudent() = false c.isPermanentResidencyWithParents() = true c.isWorking() = true
4	c.getBirthDate().getAge() = 24 c.isStudent() = false c.isPermanentResidencyWithParents() = false c.isWorking() = true
5	c.getBirthDate().getAge() = 26 c.isStudent() = false c.isPermanentResidencyWithParents() = true c.isWorking() = true
6	c.getBirthDate().getAge() = 26 c.isStudent() = false c.isPermanentResidencyWithParents() = false c.isWorking() = true

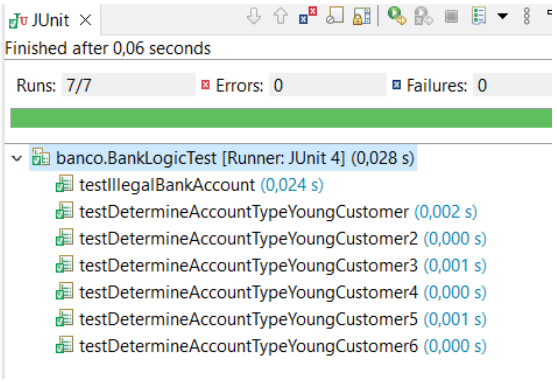
6 - Define test suits to achieve pairwise coverage by using the proposed algorithm in lectures. You can check the results by means of the software PICT1

As we had a total combination of 88 possible cases in order to get the pairwise coverage we used the tool PICT from Microsoft. In the end we finished with 23 different test suits.

Age	Student	ResidencyWithParents	Working
1	False	True	True
1000	True	False	False
18	False	True	False
-1	True	False	True
-1000	True	True	False
1	False	False	False
25	True	True	True
19	False	True	True
1000	False	True	True
17	True	False	True
0	True	False	False
19	True	False	False
-1	False	True	False
24	False	True	True
1	True	True	True
26	False	False	True
24	True	False	False
0	False	True	True
18	True	False	True
-1000	False	False	True
25	False	False	False
26	True	True	False
17	False	True	False

7 - For code snippets that include decisions, propose a set of test cases to achieve coverage of decisions.

To create the requested set of test cases, we can use the list defined in section 5 one to one. The decisions made within the code consist of the different types of bank accounts we want to detect - Therefore, we need to choose test cases with values for each detectable bank accounts type. We also need to check for possible illegal values, as this is also a type of decision (throw an expectation or don't) the code should be able to make. After defining these tests, details provided at BankLogicTestDecisions.java, we see all tests are passed.



Looking at the class BankLogic code coverage of 98.1%, we see that only the main public class is not used by the internal logic. The important decisions, however, are covered. The full report is available at: DecisionCoverageReport.pdf.

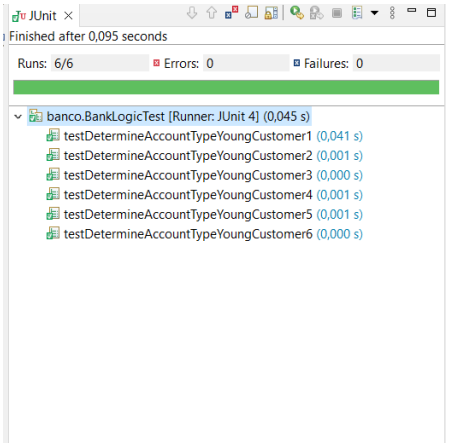
8 - For code snippets that include decisions, propose test case sets to achieve MC/DC coverage.

In this test, we need to produce all different outcomes (Bank account types) using all logically possible combinations. This test will first define the different logic checks in a table, looking at the method: determineAccountTypeYoungCustomer(Customer c), and then define tests in JUnit. Since we already know of the absence of checks for illegal values, we want to test the logic for determining all six different bank account types only.

A = Age.
B = IsStudent.
C = IsPermanentResidencyWithParents.
D = IsWorking

A	B	C	D	Logic	Dominant Condition	Expect output value
27	0	0	1	(A ∧ ¬C)∧ D)	A,C,D	“Welcome Adult life”
20	0	0	1	(A ∧ ¬C)∧ D)	A,C,D	“Jump out of the nest”
20	0	1	1	(A ∧ C∧ D)	A,C,D	“Save now”
27	0	1	1	(A ∧ C∧ D)	A,C,D	“Become independent”
17	1	0	0	(A ∧ B)	A, B	“Come on you can”
17	1	1	0	(A ∧ B ∧ C)	A,B,C	“Comfort”

Running the newly defined test cases, available at [BankLogicTestMCDCcoverage.java], we see that all test cases pass.



9 - Comment on the results of the number of test cases obtained in section 4, 5, and 6, as well as the execution of the oracles: what could be said about the coverage achieved?

In the section number four, we can see that with this code we just have one int variable and the rest were boolean variables, so we just need to evaluate the limits values of the int variable (getBirthDate().getAge()) with the differents combinations of the boolean numbers, the result it's 88 possible combinations.
From this section we could extract that with these 88 possible combinations, we could test the code with all the necessary values.

In the section number five, we want to test if all the operations works, for this task, we use a different combinations for the methods values, with these tests suits we really achieve to detect that all the combinations for the variable (determineAccountTypeYoungCustomer(Customer c)) works and with the section number 7 we really test all the combinations and we detect that all the methods works.

In the section number 6 we have have to achieve the pairwise coverage and for this task we have used the tool PICT from Microsoft, this software it´s very useful to reduce the number of test, for example, at first we had 88 possible cases, and after use the software, we have only 23 different tests suits, with these combinations, we can test all the possibilities for the method, with the exceptions and all the possible values.

About the coverage achieved, we have to say the same as we said in the exercises 7 and 8, all the tests were passed, and with a high coverage percentage, we can resume that all the tests were passed correctly and therefore, the code it's apparently correct.