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# 1. Model-based testing of the Account class

## Transition-Pair Testing

Note: See Appendix for test results for this section

State *idle*

In: T1, T5, T6, T7, T9, T10

Out: T2, T7

State *check pin*

In: T2, T3

Out: T3, T5, T6, T8, T16

State *ready*

In: T11, T12 T13, T16, T17, T18

Out: T4, T10, T11, T12, T13, T14

State *locked*

In: T4, T15, T20

Out: T15, T17, T19

State *overdrawn*

In: T8, T14, T19, T21, T22

Out: T9, T18, T20, T21, T22

Transition Pairs for State *idle*

|  |  |  |
| --- | --- | --- |
| Incoming | Outgoing | Executed By |
| T1 | T2 | Test#2 |
| T1 | T7 | Test#1 |
| T5 | T2 | Test#1 |
| T5 | T7 | Test#3 |
| T6 | T2 | Test#1 |
| T6 | T7 | Test#3 |
| T7 | T2 | Test#1 |
| T7 | T7 | Test#1 |
| T9 | T2 | Test#4 |
| T9 | T7 | Test#2 |
| T10 | T2 | Test#3 |
| T10 | T7 | Test#1 |

Transition Pairs for State *locked*

|  |  |  |
| --- | --- | --- |
| Incoming | Outgoing | Executed By |
| T4 | T15 | Test#5 |
| T4 | T17 | Test#5 |
| T4 | T19 | Impossible |
| T15 | T15 | Test#7 |
| T15 | T17 | Test#5 |
| T15 | T19 | Test#6 |
| T20 | T15 | Test#6 |
| T20 | T17 | Impossible |
| T20 | T19 | Test#6 |

Transition Pairs for State *check pin*

|  |  |  |
| --- | --- | --- |
| Incoming | Outgoing | Executed By |
| T2 | T3 | Test#1 |
| T2 | T5 | Test#1 |
| T2 | T6 | Impossible |
| T2 | T8 | Test#2 |
| T2 | T16 | Test#1 |
| T3 | T3 | Test#1 |
| T3 | T5 | Test#4 |
| T3 | T6 | Test#1 |
| T3 | T8 | Test#2 |
| T3 | T16 | Test#4 |

Transition Pairs for state *ready*

|  |  |  |
| --- | --- | --- |
| Incoming | Outgoing | Executed By |
| T11 | T4 | Test#13 |
| T11 | T10 | Test#12 |
| T11 | T11 | Test#14 |
| T11 | T12 | Test#13 |
| T11 | T13 | Test#15 |
| T11 | T14 | Test#9 |
| T12 | T4 | Test#15 |
| T12 | T10 | Test#13 |
| T12 | T11 | Test#13 |
| T12 | T12 | Test#14 |
| T12 | T13 | Test#9 |
| T12 | T14 | Test#15 |
| T13 | T4 | Test#9 |
| T13 | T10 | Test#14 |
| T13 | T11 | Test#13 |
| T13 | T12 | Test#15 |
| T13 | T13 | Test#14 |
| T13 | T14 | Test#11 |
| T16 | T4 | Test#5 |
| T16 | T10 | Test#1 |
| T16 | T11 | Test#12 |
| T16 | T12 | Test#14 |
| T16 | T13 | Test#13 |
| T16 | T14 | Test#15 |
| T17 | T4 | Test#5 |
| T17 | T10 | Test#12 |
| T17 | T11 | Test#15 |
| T17 | T12 | Test#13 |
| T17 | T13 | Test#15 |
| T17 | T14 | Test#5 |
| T18 | T4 | Test#12 |
| T18 | T10 | Test#2 |
| T18 | T11 | Test#9 |
| T18 | T12 | Test#9 |
| T18 | T13 | Test#11 |
| T18 | T14 | Test#10 |

Transition Pairs for State *overdrawn*

|  |  |  |
| --- | --- | --- |
| Incoming | Outgoing | Executed By |
| T8 | T9 | Test#2 |
| T8 | T18 | Test#2 |
| T8 | T20 | Test#6 |
| T8 | T21 | Test#8 |
| T8 | T22 | Test#8 |
| T14 | T9 | Test#9 |
| T14 | T18 | Test#9 |
| T14 | T20 | Test#11 |
| T14 | T21 | Test#11 |
| T14 | T22 | Test#5 |
| T19 | T9 | Test#10 |
| T19 | T18 | Test#11 |
| T19 | T20 | Test#6 |
| T19 | T21 | Test#7 |
| T19 | T22 | Test#6 |
| T21 | T9 | Test#8 |
| T21 | T18 | Test#7 |
| T21 | T20 | Test#8 |
| T21 | T21 | Test#8 |
| T21 | T22 | Test#6 |
| T22 | T9 | Test#5 |
| T22 | T18 | Test#10 |
| T22 | T20 | Test#10 |
| T22 | T21 | Test#6 |
| T22 | T22 | Test#10 |

## Test Cases

Test#1: open 500 1 2 login 50 login 50 login 2 logout login 2 pin 50 pin 50 pin 50 login 50 login 2 pin 1 logout login 50

Executes: T1 T7 T7 T2 T5 T2 T3 T3 T6 T2 T16 T10 T7

Test#2: open 400 1 2 login 2 pin 1 logout login 50 login 2 pin 50 pin 1 deposit 200 logout

Executes: T1 T2 T8 T9 T7 T2 T3 T8 T18 T10

Test#3: open 500 1 2 login 2 logout login 50 login 2 pin 50 pin 50 pin 50 login 50 login 2 pin 1 logout login 2 logout

Executes: T1 T2 T5 T7 T2 T3 T3 T6 T7 T2 T16 T10 T2 T5

Test#4: open 400 1 2 login 2 pin 1 logout login 2 pin 50 logout login 2 pin 50 pin 1 logout

Executes: T1 T2 T8 T9 T2 T3 T5 T2 T3 T16 T10

Test#5: open 600 1 2 login 2 pin 1 lock 3 balance unlock 3 lock 3 unlock 3 withdraw 200 balance logout

Executes: T1 T2 T16 T4 T15 T17 T4 T17 T14 T22 T9

Test#6: open 400 1 2 login 2 pin 1 lock 3 balance unlock 3 lock 3 unlock 3 balance deposit 50 balance logout

Executes: T1 T2 T8 T20 T15 T19 T20 T19 T22 T21 T22 T9

Test#7: open 400 1 2 login 2 pin 1 lock 3 balance balance unlock 3 deposit 20 deposit 400 withdraw 400 deposit 20 balance logout

Executes: T1 T2 T8 T20 T15 T15 T19 T21 T18 T14

Test#8: open 400 1 2 login 2 pin 1 deposit 20 logout login 2 pin 1 deposit 20 deposit 20 lock 3 unlock 3 logout login 2 pin 1 balance logout

Executes: T1 T2 T8 T21 T9 T2 T8 T21 T21 T20 T19 T9 T2 T8 T22 T9

Test#9: open 400 1 2 login 2 pin 1 deposit 200 withdraw 20 withdraw 200 deposit 300 deposit 20 balance lock 3 unlock 3 withdraw 300 logout

Executes: T1 T2 T8 T18 T11 T14 T18 T12 T13 T4 T17 T14 T9

Test#10: open 400 1 2 login 2 pin 1 lock 3 unlock 3 logout login 2 pin 1 deposit 200 withdraw 200 balance balance lock 3 unlock 3 balance deposit 300 logout

Executes: T1 T2 T8 T20 T19 T9 T2 T8 T18 T14 T22 T22 T20 T19 T22 T18 T10

Test#11: open 400 1 2 login 2 pin 1 lock 3 unlock 3 deposit 200 withdraw 200 lock 3 unlock 3 deposit 300 balance withdraw 300 deposit 1 lock 3 unlock 3 deposit 500 logout

Executes: T1 T2 T8 T20 T19 T18 T14 T20 T19 T18 T13 T14 T21 T20 T19 T18 T10

Test#12: open 400 1 2 login 2 pin 1 deposit 300 lock 3 unlock 3 logout login 2 pin 1 withdraw 1 logout

Executes: T1 T2 T8 T18 T4 T17 T10 T2 T16 T11 T10

Test#13: open 600 1 2 login 2 pin 1 balance withdraw 1 lock 3 unlock 3 deposit 20 withdraw 1 deposit 1 logout

Executes: T1 T2 T16 T13 T11 T4 T17 T12 T11 T12 T10

Test#14: open 600 1 2 login 2 pin 1 deposit 1 deposit 1 withdraw 1 withdraw 1 balance balance logout

Executes: T1 T2 T16 T12 T12 T11 T11 T13 T13 T10

Test#15: open 600 1 2 login 2 pin 1 withdraw 200 deposit 300 balance deposit 20 withdraw 300 deposit 400 withdraw 5 balance deposit 5 lock 3 unlock 3 withdraw 5 lock 3 unlock 3 balance logout

Execute: T1 T2 T16 T14 T18 T13 T12 T14 T18 T11 T13 T12 T4 T17 T11 T4 T17 T13 T10

## Un-executable Transition Pairs:

State *check pin*

T2-T6 is impossible because the pre-condition to T6 is “attempts = 2” but the post-condition of T2 is “attempts = 0.” T6 must always be immediately preceded by T3, Thus T2 can never be immediately before T6

State *locked*

T4-T19 is impossible because the post-condition with regards to balance for T4 is “balance >= 500” but the pre-condition for T19 with regards to balance is “balance < 500.” These cannot both be true, and thus T19 can never come immediately after T4

T20-T17 is impossible because the post-condition with regards to balance for T20 is “balance < 500” but the pre-condition with respect to balance for T17 is “balance > 500.” Invoking the unlock operation with the correct lock number after transition T20 would execute T19, not T17, because balance is less than $500. Thus T17 can never occur immediately after T20

# 2. Testing default (ghost) transitions of the Account class

State *idle* default transitions

|  |  |
| --- | --- |
| Transition operation | Executed By |
| open(x, y, z) | Test#16 |
| logout() | Test#16 |
| pin(x) | Test#16 |
| deposit(d) | Test#16 |
| withdraw(w) | Test#16 |
| balance() | Test#16 |
| lock(x) | Test#16 |
| unlock(x) | Test#16 |

State *check pin* default transitions

|  |  |
| --- | --- |
| Transition operation | Executed By |
| open(x, y, z) | Test#17 |
| login(x) | Test#17 |
| deposit(d) | Test#17 |
| withdraw(w) | Test#17 |
| balance() | Test#17 |
| lock(x) | Test#17 |
| unlock(x) | Test#17 |

State *ready* default transitions

|  |  |
| --- | --- |
| Transition operation | Executed By |
| open(x, y, z) | Test#18 |
| pin(x) | Test#18 |
| login(x) | Test#18 |
| unlock(x) | Test#18 |

State *locked* default transitions

|  |  |
| --- | --- |
| Transition operation | Executed By |
| open(x, y, z) | Test#19 |
| login(x) | Test#19 |
| logout() | Test#19 |
| pin(x) | Test#19 |
| deposit(d) | Test#19 |
| withdraw(w) | Test#19 |
| lock(x) | Test#19 |
| unlock(x)[x =/= k] | Test#19 |

State *overdrawn* default transitions

|  |  |
| --- | --- |
| Transition operation | Executed By |
| open(x, y, z) | Test#20 |
| pin(x) | Test#20 |
| withdraw(d) | Test#20 |
| login(x) | Test#20 |
| unlock(x) | Test#20 |

## Test Cases

Test#16: open 500 1 2 open 750 15 20 logout pin 1 deposit 50 withdraw 20 balance lock 3 unlock 3

Executes all ghost transitions in state *idle*

Test#17: open 500 1 2 login 2 open 750 15 20 login 2 deposit 50 withdraw 20 balance lock 3 unlock 3

Executes all ghost transitions in state *check pin*

Test#18: open 500 1 2 login 2 pin 1 open 750 1 2 pin 1 login 2 unlock 3

Executes all ghost transitions in state *ready*

Test#19: open 500 1 2 login 2 pin 1 lock 3 open 750 15 20 login 2 logout pin 1 deposit 50 withdraw 20 lock 3 unlock 7

Executes all ghost transitions in state *locked*

Test#20: open 400 1 2 login 2 pin 1 open 750 15 20 login 20 pin 15 withdraw 20 unlock 3

Executes all ghost transitions in state *overdrawn*

# 3. Multiple-condition Testing

## Method open(int x, int y, int z):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| x > 0 | x4 == -1 | y > 0 | z > 0 | Executed By: |
| T | T | T | T | Test#21 |
| T | T | T | F | Test#22 |
| T | T | F | T | Test#23 |
| T | T | F | F | Test#24 |
| T | F | T | T | Test#25 |
| T | F | T | F | Test#26 |
| T | F | F | T | Test#27 |
| T | F | F | F | Test#28 |
| F | T | T | T | Test#29 |
| F | T | T | F | Test#30 |
| F | T | F | T | Test#31 |
| F | T | F | F | Test#32 |
| F | F | T | T | Test#33 |
| F | F | T | F | Test#34 |
| F | F | F | T | Test#35 |
| F | F | F | F | Test#36 |

## Method pin(int x):

1)

|  |  |
| --- | --- |
| x4 != 1 | Executed By: |
| T | Test#39 |
| F | Test#37 |

2)

|  |  |
| --- | --- |
| x == x3 | Executed By: |
| T | Test#37 |
| F | Test#38 |

3)

|  |  |
| --- | --- |
| x9 >= x0 | Executed By: |
| T | Test#38 |
| F | Test#38 |

## Method *logout()*:

|  |  |  |
| --- | --- | --- |
| x4 == 0 | x2 == 1 | Executed By: |
| T | T | Impossible |
| T | F | Test#40 |
| F | T | Test#41 |
| F | F | Test#42 |

Branch True True is not executable because x4 == 0 being True means we are in state *idle*, but x2 == 1 being True can only happen when we are in the *locked* state. It cannot be the case that we are both in state *idle* and *locked* at the same time.

## Method login(int x):

1)

|  |  |
| --- | --- |
| x4 != 0 | Executed By: |
| T | Test#43 |
| F | Test#43 |

2)

|  |  |
| --- | --- |
| x5 == x | Executed By: |
| T | Test#43 |
| F | Test#43 |

## Method balance():

|  |  |
| --- | --- |
| x4 != 2 | Executed By: |
| T | Test#44 |
| F | Test#44 |

## Method lock(int x):

1)

|  |  |
| --- | --- |
| x4 != 2 | Executed By: |
| T | Test#47 |
| F | Test#45 |

2)

|  |  |
| --- | --- |
| x == x3 | Executed By: |
| T | Test#48 |
| F | Test#45 |

3)

|  |  |
| --- | --- |
| x2 == 0 | Executed By: |
| T | Test#45 |
| F | Test#46 |

## Method unlock(int x):

1)

|  |  |
| --- | --- |
| x4 != 2 | Executed By: |
| T | Test#49 |
| F | Test#50 |

2)

|  |  |  |
| --- | --- | --- |
| x2 == 1 | x == x8 | Executed By: |
| T | T | Test#50 |
| T | F | Test#51 |
| F | T | Test#52 |
| F | F | Test#53 |

## Method deposit(int d):

1)

|  |  |
| --- | --- |
| x4 != 2 | Executed By: |
| T | Test#54 |
| F | Test#55 |

2)

|  |  |
| --- | --- |
| x2 == 1 | Executed By: |
| T | Test#54 |
| F | Test#55 |

3)

|  |  |  |
| --- | --- | --- |
| x1 + d < x7 | d > 0 | Executed By: |
| T | T | Test#56 |
| T | F | Test#56 |
| F | T | Test#55 |
| F | F | Test#57 |

4)

|  |  |
| --- | --- |
| d > 0 | Executed By: |
| T | Test#55 |
| F | Test#57 |

## Method withdraw(int d):

1)

|  |  |
| --- | --- |
| x4 != 2 | Executed By: |
| T | Test#58 |
| F | Test#58 |

2)

|  |  |
| --- | --- |
| x2 == 1 | Executed By: |
| T | Test#59 |
| F | Test#58 |

3)

|  |  |  |
| --- | --- | --- |
| x1 > w | w > 0 | Executed By: |
| T | T | Test#58 |
| T | F | Test#59 |
| F | T | Test#62 |
| F | F | Test#63 |

4)

|  |  |
| --- | --- |
| x1 < x7 | Executed By: |
| T | Test#60 |
| F | Test#58 |

5)

|  |  |
| --- | --- |
| x1 < x7 | Executed By: |
| T | Test#61 |
| F | Test#58 |

## Test Cases

Test#21: open 1 2 3

Covers: open T T T T

Test#22: open 1 2 -1

Covers: open T T T F

Test#23: open 1 -1 3

Covers: open T T F T

Test#24: open 1 -1 -1

Covers: open T T F F

Test#25: open -1 2 3

Covers: open T F T T

Test#26: open -1 2 -1

Covers: open T F T F

Test#27: open -1 -1 3

Covers: open T F F T

Test#28: open -1 -1 -1

Covers: open T F F F

Test#29: open 1 1 1 open 1 2 3

Covers: open F T T T

Test#30: open 1 1 1 open 1 2 -1

Covers: open F T T F

Test#31: open 1 1 1 open 1 -1 3

Covers: open F T F T

Test#32: open 1 1 1 open 1 -1 -1

Covers: open F T F F

Test#33: open 1 1 1 open -1 1 1

Covers open F F T T

Test#34: open 1 1 1 open -1 1 -1

Covers open F F T F

Test#35: open 1 1 1 open -1 -1 3

Covers: open F F F T

Test#36: open 1 1 1 open -1 -1 -1

Covers: open F F F F

Test#37: open 500 1 2 login 2 pin 1 logout

Covers: pin 1-F, 2T

Test#38: open 500 1 2 login 2 pin 50 pin 50 pin 50

Covers: pin 2-F, 3-T, 3-F

Test#39: open 500 1 2 pin 1

Covers: pin 1-T

Test#40: open 1 1 1 logout

Covers: logout T F

Test#41: open 500 1 2 login 2 pin 1 lock 3 logout

Covers: logout F T

Test#42: open 500 1 2 login 2 logout

Covers: logout F F

Test#43: open 500 1 2 login 3 login 2 pin 1 login 2

Covers: login 1-F, 2-F, 2-T, 1-T

Test#44: open 500 1 2 balance login 2 pin 1 balance logout

Covers: balance T, balance F

Test#45: open 500 1 2 login 2 pin 1 lock 3

Covers: lock 1-F, 2-F, 3-T

Test#46: open 500 1 2 login 2 lock 3

Covers: lock 3-F

Test#47: open 500 1 2 lock 3

Covers: lock 1-T

Test#48: open 500 1 2 login 2 pin 1 lock 1

Covers: lock 2-T

Test#49: open 500 1 2 unlock 3

Covers: unlock 1-T

Test#50: open 500 1 2 login 2 pin 1 lock 3 unlock 3 logout

Covers: unlock 1-F, 2-T-T

Test#51: open 500 1 2 login 2 pin 1 lock 3 unlock 4

Covers: unlock 2-T-F

Test#52: open 500 1 2 login 2 pin 1 lock 3 unlock 3 unlock 3

Covers: unlock 2-F-T

Test#53: open 500 1 2 login 2 pin 1 lock 3 unlock 3 unlock 7

Covers: unlock 2-F-F

Test#54: open 500 1 2 deposit 50 login 2 pin 1 lock 3 deposit 50 unlock 3 logout

Covers: deposit 1-T, 2-T

Test#55: open 500 1 2 login 2 pin 1 deposit 50 logout

Covers: deposit 1-F, 2-F, 3-F-T, 4-T

Test#56: open 400 1 2 login 2 pin 1 deposit 50 deposit -50

Covers: deposit 3-T-T, deposit 3-T-F

Test#57: open 500 1 2 login 2 pin 1 deposit -50 logout

Covers: deposit 3-F-F, 4-F

Test#58: open 600 1 2 withdraw 50 login 2 pin 1 withdraw 50 logout

Covers: withdraw 1-T, 1-F, 2-F, 3-T-T, 4-F, 5-F

Test#59: open 400 1 2 login 2 pin 1 lock 3 withdraw 50 unlock 3 withdraw -50 logout

Covers: withdraw 2-T, 3-T-F

Test#60: open 400 1 2 login 2 pin 1 withdraw 20 logout

Covers: withdraw 4-T

Test#61: open 500 1 2 login 2 pin 1 withdraw 20 logout

Covers: withdraw 5-T

Test#62: open 500 1 2 login 2 pin 1 withdraw 600 logout

Covers: withdraw 3-F-T

Test#63: open 500 1 2login 2 pin 1 withdraw 499 withdraw -1 logout

Covers: withdraw 3-F-F

# 4. Test Suite & Results of execution

## Test Suite Verification

All tests are syntax-error free. Here is the output of the test-suite checker on TS.txt:

Test#1:

open(500,1,2) method

login(50) method

login(50) method

login(2) method

logout() method

login(2) method

pin(50) method

pin(50) method

pin(50) method

login(50) method

login(2) method

pin(1) method

logout() method

login(50) method

Test#2:

open(400,1,2) method

login(2) method

pin(1) method

logout() method

login(50) method

login(2) method

pin(50) method

pin(1) method

deposit(200) method

logout() method

Test#3:

open(500,1,2) method

login(2) method

logout() method

login(50) method

login(2) method

pin(50) method

pin(50) method

pin(50) method

login(50) method

login(2) method

pin(1) method

logout() method

login(2) method

logout() method

Test#4:

open(400,1,2) method

login(2) method

pin(1) method

logout() method

login(2) method

pin(50) method

logout() method

login(2) method

pin(50) method

pin(1) method

logout() method

Test#5:

open(600,1,2) method

login(2) method

pin(1) method

lock(3) method

balance() method

unlock(3) method

lock(3) method

unlock(3) method

withdraw(200) method

balance() method

logout() method

Test#6:

open(400,1,2) method

login(2) method

pin(1) method

lock(3) method

balance() method

unlock(3) method

lock(3) method

unlock(3) method

balance() method

deposit(50) method

balance() method

logout() method

Test#7:

open(400,1,2) method

login(2) method

pin(1) method

lock(3) method

balance() method

balance() method

unlock(3) method

deposit(20) method

deposit(400) method

withdraw(400) method

deposit(20) method

balance() method

logout() method

Test#8:

open(400,1,2) method

login(2) method

pin(1) method

deposit(20) method

logout() method

login(2) method

pin(1) method

deposit(20) method

deposit(20) method

lock(3) method

unlock(3) method

logout() method

login(2) method

pin(1) method

balance() method

logout() method

Test#9:

open(400,1,2) method

login(2) method

pin(1) method

deposit(200) method

withdraw(20) method

withdraw(200) method

deposit(300) method

deposit(20) method

balance() method

lock(3) method

unlock(3) method

withdraw(300) method

logout() method

Test#10:

open(400,1,2) method

login(2) method

pin(1) method

lock(3) method

unlock(3) method

logout() method

login(2) method

pin(1) method

deposit(200) method

withdraw(200) method

balance() method

balance() method

lock(3) method

unlock(3) method

balance() method

deposit(300) method

logout() method

Test#11:

open(400,1,2) method

login(2) method

pin(1) method

lock(3) method

unlock(3) method

deposit(200) method

withdraw(200) method

lock(3) method

unlock(3) method

deposit(300) method

balance() method

withdraw(300) method

deposit(1) method

lock(3) method

unlock(3) method

deposit(500) method

logout() method

Test#12:

open(400,1,2) method

login(2) method

pin(1) method

deposit(300) method

lock(3) method

unlock(3) method

logout() method

login(2) method

pin(1) method

withdraw(1) method

logout() method

Test#13:

open(600,1,2) method

login(2) method

pin(1) method

balance() method

withdraw(1) method

lock(3) method

unlock(3) method

deposit(20) method

withdraw(1) method

deposit(1) method

logout() method

Test#14:

open(600,1,2) method

login(2) method

pin(1) method

deposit(1) method

deposit(1) method

withdraw(1) method

withdraw(1) method

balance() method

balance() method

logout() method

Test#15:

open(600,1,2) method

login(2) method

pin(1) method

withdraw(200) method

deposit(300) method

balance() method

deposit(20) method

withdraw(300) method

deposit(400) method

withdraw(5) method

balance() method

deposit(5) method

lock(3) method

unlock(3) method

withdraw(5) method

lock(3) method

unlock(3) method

balance() method

logout() method

Test#16:

open(500,1,2) method

open(750,15,20) method

logout() method

pin(1) method

deposit(50) method

withdraw(20) method

balance() method

lock(3) method

unlock(3) method

Test#17:

open(500,1,2) method

login(2) method

open(750,15,20) method

login(2) method

deposit(50) method

withdraw(20) method

balance() method

lock(3) method

unlock(3) method

Test#18:

open(500,1,2) method

login(2) method

pin(1) method

open(750,1,2) method

pin(1) method

login(2) method

unlock(3) method

Test#19:

open(500,1,2) method

login(2) method

pin(1) method

lock(3) method

open(750,15,20) method

login(2) method

logout() method

pin(1) method

deposit(50) method

withdraw(20) method

lock(3) method

unlock(7) method

Test#20:

open(400,1,2) method

login(2) method

pin(1) method

open(750,15,20) method

login(20) method

pin(15) method

withdraw(20) method

unlock(3) method

Test#21:

open(1,2,3) method

Test#22:

open(1,2,-1) method

Test#23:

open(1,-1,3) method

Test#24:

open(1,-1,-1) method

Test#25:

open(-1,2,3) method

Test#26:

open(-1,2,-1) method

Test#27:

open(-1,-1,3) method

Test#28:

open(-1,-1,-1) method

Test#29:

open(1,1,1) method

open(1,2,3) method

Test#30:

open(1,1,1) method

open(1,2,-1) method

Test#31:

open(1,1,1) method

open(1,-1,3) method

Test#32:

open(1,1,1) method

open(1,-1,-1) method

Test#33:

open(1,1,1) method

open(-1,1,1) method

Test#34:

open(1,1,1) method

open(-1,1,-1) method

Test#35:

open(1,1,1) method

open(-1,-1,3) method

Test#36:

open(1,1,1) method

open(-1,-1,-1) method

Test#37:

open(500,1,2) method

login(2) method

pin(1) method

logout() method

Test#38:

open(500,1,2) method

login(2) method

pin(50) method

pin(50) method

pin(50) method

Test#39:

open(500,1,2) method

pin(1) method

Test#40:

open(1,1,1) method

logout() method

Test#41:

open(500,1,2) method

login(2) method

pin(1) method

lock(3) method

logout() method

Test#42:

open(500,1,2) method

login(2) method

logout() method

Test#43:

open(500,1,2) method

login(3) method

login(2) method

pin(1) method

login(2) method

Test#44:

open(500,1,2) method

balance() method

login(2) method

pin(1) method

balance() method

logout() method

Test#45:

open(500,1,2) method

login(2) method

pin(1) method

lock(3) method

Test#46:

open(500,1,2) method

login(2) method

lock(3) method

Test#47:

open(500,1,2) method

lock(3) method

Test#48:

open(500,1,2) method

login(2) method

pin(1) method

lock(1) method

Test#49:

open(500,1,2) method

unlock(3) method

Test#50:

open(500,1,2) method

login(2) method

pin(1) method

lock(3) method

unlock(3) method

logout() method

Test#51:

open(500,1,2) method

login(2) method

pin(1) method

lock(3) method

unlock(4) method

Test#52:

open(500,1,2) method

login(2) method

pin(1) method

lock(3) method

unlock(3) method

unlock(3) method

Test#53:

open(500,1,2) method

login(2) method

pin(1) method

lock(3) method

unlock(3) method

unlock(7) method

Test#54:

open(500,1,2) method

deposit(50) method

login(2) method

pin(1) method

lock(3) method

deposit(50) method

unlock(3) method

logout() method

Test#55:

open(500,1,2) method

login(2) method

pin(1) method

deposit(50) method

logout() method

Test#56:

open(400,1,2) method

login(2) method

pin(1) method

deposit(50) method

deposit(-50) method

Test#57:

open(500,1,2) method

login(2) method

pin(1) method

deposit(-50) method

logout() method

Test#58:

open(600,1,2) method

withdraw(50) method

login(2) method

pin(1) method

withdraw(50) method

logout() method

Test#59:

open(400,1,2) method

login(2) method

pin(1) method

lock(3) method

withdraw(50) method

unlock(3) method

withdraw(-50) method

logout() method

Test#60:

open(400,1,2) method

login(2) method

pin(1) method

withdraw(20) method

logout() method

Test#61:

open(500,1,2) method

login(2) method

pin(1) method

withdraw(20) method

logout() method

Test#62:

open(500,1,2) method

login(2) method

pin(1) method

withdraw(600) method

logout() method

Test#63:

open(500,1,2) method

login(2) method

pin(1) method

withdraw(499) method

withdraw(-1) method

logout() method

The test suite has been checked.

No errrors have been detected.

## Test Results

All tests passed successfully (with the expected results).

Details about each individual test case is provided separately in “CS 589 Project Test Results.docx” which will NOT be printed, but will be uploaded as a separate file from this report onto BlackBoard.

# 5. Conclusions

The implementation of the testing environment was straightforward and easy, given the expectations. However, it proved to be very limited in its usefulness other than showing the current state given the given input and showing some other variables of the program. I found myself doing a lot of calculations manually, and following program progression in my own mind because modifying the test driver program would prove counter-intuitive. The reason for this is that oftentimes changes were required only for one test to show the evaluation of a certain sequence of calls or of a particular conditional branch. Those changes would become irrelevant in other tests that invoked the changes.

One activity related to class testing that is blatantly manual is test suite execution. 63 tests required 63 separate series of inputs on a new invocation of the driver program to drive each test. This is because test result verification in our circumstance is manual by design.

One possible improvement would be to create a test suite executor.

Automating this process would actually be a challenging task, however, since special methods would need to be implemented and called upon each operation of the Account class. These special methods would have to check a lot of series of return values from the Account class methods, and the length of the arrays containing there return values is not fixed. Furthermore, the test suite executor would have to be aware of certain test success criterion which would need to be input from the user and verified. Thus, this task would take a considerable amount of effort. However, it would mean that the tester/user only needs to design test cases, and not worry about executing them manually as well.

# 6. Account class and Test driver source code

Note, source code of the program has not been changed at all. Some testing oriented methods were added, and comments were added to the 10 variables for easy reminders about their role in the program

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