

Testing

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Unit Tests

Transaction

- confirm that all Transaction attributes are set to the correct passed values in the test
- confirm that Transaction attributes cannot be modified after executing makeConstant() method

Results:

```
Running unitTestTransaction
-----
Test Data: Timestamp = 1564972893 | Amount = 5.56 | Sender = Node A | Receiver = Node B
Creating empty Transaction... done.

Transaction: 0073F9C0
Transaction.timestamp = 0
Transaction.amount = 0
Transaction.sender = 
Transaction.receiver = 

Setting data attributes to test data... done.

Transaction: 0073F9C0
Transaction.timestamp = 1564972893
Transaction.amount = 5.56
Transaction.sender = Node A
Transaction.receiver = Node B

Setting Transaction to uneditable state... done.

Attempting to modify Transaction.

Transaction: 0073F9C0
Transaction.timestamp = 1564972893
Transaction.amount = 5.56
Transaction.sender = Node A
Transaction.receiver = Node B

unitTestTransaction completed
Press any key to continue...
```

Block

- confirm that the constructor creates a Block instance with correct attribute values
- confirm that CalculateHash() produces a hash string with the correct Nonce
- confirm that the GetData() method returns a Transaction instance with the correct values
- confirm that copying a Block copies all attribute values (hash can vary for improved encryption)

Results:

```
Running unitTestBlock
-----
Test Data: Time: 0 | Amount: 328.99 | Sender: Node A | Receiver: Node B
Creating a Block holding the Transaction data: done.

Block hash: 06cf2d09a0e5c47b704ed96466e12f58fb6c05e4b6f79e7f0fa16399aced6cf0
Block: 06cf2d09a0e5c47b704ed96466e12f58fb6c05e4b6f79e7f0fa16399aced6cf0
Data: Timestamp: 0, Amount: 328.99 crypto, sender: Node A, receiver: Node B

Creating a second Block with the same data
Block 2 hash: 06cf2d09a0e5c47b704ed96466e12f58fb6c05e4b6f79e7f0fa16399aced6cf0

Copying a Block from Block 1...
Block: 06cf2d09a0e5c47b704ed96466e12f58fb6c05e4b6f79e7f0fa16399aced6cf0
Data: Timestamp: 0, Amount: 328.99 crypto, sender: Node A, receiver: Node B

unitTestBlock completed
Press any key to continue...
_
```

Blockchain

- confirm that the constructor creates a Blockchain with only an origin block
- confirm that adding a Block to the chain creates a new last Block in the chain with the desired Transaction attributes, and the size of the chain increases

Results:

```
Running unitTestBlockchain
-----

Test data:
Block 1: Time: 1111 | Amount: 1 | Sender: B2 | Receiver: B1
Block 2: Time: 2222 | Amount: 2 | Sender: B1 | Receiver: B2
Block 3: Time: 3333 | Amount: 3 | Sender: B1 | Receiver: B3

Created a Blockchain
Blockchain size: 1 (should be 1)

Added blocks to chain... (New size should be 4)
Blockchain(00B9F59C)
contains 4 blocks
Block:
Data: Timestamp: 1565010501, Amount: 0 crypto, sender: Genesis, receiver: Genesis
Block: 0004a48b1454765cc4fc2a4706159ad366a70ae51367f160b6a2739a2ed104b7
Data: Timestamp: 1111, Amount: 1 crypto, sender: B2, receiver: B1
Block: 000824a7d3df09ccbce4bf9c9745b334fd02129cd2346ed39c78149ec78f6597
Data: Timestamp: 2222, Amount: 2 crypto, sender: B1, receiver: B2
Block: 00022181a519a03e8edebf3ce474ae184c3aa44cf3dc0e718e20c42c3c77db11
Data: Timestamp: 3333, Amount: 3 crypto, sender: B1, receiver: B3

unitTestBlockchain completed
Press any key to continue...
```

Node

- confirm that getters and setters work
- confirm that when calling `node1.addConnection(node2)` then both nodes are connected to one another
- confirm Nodes correctly modify their Blockchains and Blockchains have correct Transaction data
- confirm that a Node does not crash the program when a DataManager is not connected
 - o instead an appropriate error message is printed

Results:

```
Running unitTestNode
-----
Testing Node connections...
Created nodes n1 and n2
Is n1 connected to n2? 0
Is n2 connected to n1? 0
Connecting them now...
Is n1 connected to n2? 1
Is n2 connected to n1? 1
Press any key to continue...
k
Testing Node updating Blockchains and Notifications...
n1 = 00CFFC8C
n2 = 00CFFC3C
n3 = 00CFFBEC

Test data:
Block 1: Time: 1111 | Amount: 1 | Sender: B2 | Receiver: B1
Block 2: Time: 2222 | Amount: 2 | Sender: B1 | Receiver: B2
Block 3: Time: 3333 | Amount: 3 | Sender: B1 | Receiver: B3

Printing master blockchain...
Blockchain(00CFF840)
contains 4 blocks
Block:
Data: Timestamp: 1565026321, Amount: 0 crypto, sender: Genesis, receiver: Genesis
Block: 000d4d0f7a942334bc31144b1c6e7ba3ef8c414664a2a4e1a837a02a9110909
Data: Timestamp: 1111, Amount: 1 crypto, sender: B2, receiver: B1
Block: 000a629b215617018d919c3d9e8fa6932e63abb3aaf5ae5c41b7543dc439ce7
Data: Timestamp: 2222, Amount: 2 crypto, sender: B1, receiver: B2
Block: 000dc0499e588495b5a7815d2f9f1c10d4e67b8f4523404ef6ec1446097962
Data: Timestamp: 3333, Amount: 3 crypto, sender: B1, receiver: B3
Press any key to continue...
k
ERROR: Node ptr to manager is nullptr!
ERROR: Node ptr to manager is nullptr!
ERROR: Node ptr to manager is nullptr!
ERROR: Node ptr to manager is nullptr!
ERROR: Node ptr to manager is nullptr!
ERROR: Node ptr to manager is nullptr!

Printing blockchains in each Node...
Node 1:
Blockchain(00CFF3E0)
contains 4 blocks
Block:
Data: Timestamp: 1565026317, Amount: 0 crypto, sender: Genesis, receiver: Genesis
Block: 000cc9d14e4fb260a9d869649bc6d8cb9c68d6292072aee0ae18d107748870ef
Data: Timestamp: 1111, Amount: 1 crypto, sender: B2, receiver: B1
Block: 000e67ae4917c8e42df19bf743ad5b80c13e809206b83293c229fd6d1a7594dd
Data: Timestamp: 2222, Amount: 2 crypto, sender: B1, receiver: B2
Block: 0004858d4be647cf3c9482da070b3f2be357365366b5a63037e6314324efb718
Data: Timestamp: 3333, Amount: 3 crypto, sender: B1, receiver: B3

Node 2:
Blockchain(00CFF3C4)
contains 4 blocks
Block:
Data: Timestamp: 1565026317, Amount: 0 crypto, sender: Genesis, receiver: Genesis
Block: 0002056cd8f940f5755ed22a7ccd72c7077f0741c91a6aa16095be1466004852
Data: Timestamp: 1111, Amount: 1 crypto, sender: B2, receiver: B1
Block: 00090874c40ad5aa4e527482182211e95e16017dd7843bdc99d2e161125f1386
Data: Timestamp: 2222, Amount: 2 crypto, sender: B1, receiver: B2
Block: 000e0e3501b1b71cc80b7ef41f7e7b6a9c42940a8ecce3fd4affbfdd98ac6c9
Data: Timestamp: 3333, Amount: 3 crypto, sender: B1, receiver: B3

Node 3:
Blockchain(00CFF3A8)
contains 4 blocks
Block:
Data: Timestamp: 1565026317, Amount: 0 crypto, sender: Genesis, receiver: Genesis
Block: 000a64e9c3e98c7902faae2a5f069b25d40d832cdf02318a599e634a78c97d81
Data: Timestamp: 1111, Amount: 1 crypto, sender: B2, receiver: B1
Block: 00069e4df8c0de81914c099c2bc706c77a743466b044ab9ecc8600cd267a4ea7
Data: Timestamp: 2222, Amount: 2 crypto, sender: B1, receiver: B2
Block: 000d4d50e30566943c18c28dfa9fa36f94b669592a399a695df26c56d63a410
Data: Timestamp: 3333, Amount: 3 crypto, sender: B1, receiver: B3

unitTestNode completed
Press any key to continue...
```

Driver

- confirm that getters and setters work

Results:

```
Running unitTestDriver
-----
Test data: Time Rate = 12
Creating an empty Driver
Driver.timeSinceLastAction = 0

calling driver.modifyTimeSinceLastAction(12)
Driver.timeSinceLastAction = 12(should be: 12)

calling driver.modifyTimeSinceLastAction(12)
Driver.timeSinceLastAction = 24(should be: 24)

unitTestDriver completed
Press any key to continue...
```

DataManager

-confirm that getters and setters work

Results:

```
Running unitTestDataManager
-----
Test Data: Initial Amount: 11.25 | Initial Transactions: 0 | Initial Nodes: 3
CryptoRate: 3.5 | New Nodes: 2 | Time Rate: 10
End Amount: 14.75 | End Transactions: 1 | End Nodes: 5

Created empty DataManager
DataManager: 0113FC44
DataManager.totalCrypto = 0
DataManager.totalTransactions = 0
DataManager.cryptoPerMine = 0
DataManager.totalNodes = 0
DataManager.timeRate = 0
DataManager.timePassed = 0

Setting DataManager initial values
DataManager: 0113FC44
DataManager.totalCrypto = 11.25
DataManager.totalTransactions = 0
DataManager.cryptoPerMine = 3.5
DataManager.totalNodes = 3
DataManager.timeRate = 10
DataManager.timePassed = 0

Modifying DataManager values
DataManager: 0113FC44
DataManager.totalCrypto = 14.75
DataManager.totalTransactions = 1
DataManager.cryptoPerMine = 3.5
DataManager.totalNodes = 5
DataManager.timeRate = 10
DataManager.timePassed = 10

unitTestDataManager completed
Press any key to continue...
```

Model

- confirm that when a given Event type is passed to the Model, that it takes the corresponding action

Results:

```
Executing unitTestModel()
-----
Model.running = 1 (should be 1)

Pausing Model...Model.takeEvent()
Model.update()
Model is processing an event...
Model.updateModel()
Model.Event = EventPause
Model is pushing a Notice to Viewer...
done.
Model.running = 0 (should be 0)

Now unpausing Model...
Model.takeEvent()
Model.update()
Model is processing an event...
Model.updateModel()
Model.Event = EventPause
Model is pushing a Notice to Viewer...
...done.
Model.running = 1 (should be 1)

Increasing Model speed...
Model.takeEvent()
Model.update()
Model is processing an event...
Model.updateModel()
Model.Event = EventSpeedChange
Model parsed Event = EventSpeedChange(SPEEDUP)
Model is pushing a Notice to Viewer...
...done.

Decreasing Model speed...
Model.takeEvent()
Model.update()
Model is processing an event...
Model.updateModel()
Model.Event = EventSpeedChange
Model parsed Event = EventSpeedChange(SLOWDOWN)
Model is pushing a Notice to Viewer...
..done.
unitTestModel() ending...
Press any key to continue...
```

Controller

- confirm that when a given Input type is received by the Controller, then it creates the corresponding Event type

Results:

```
Executing unitTestModel()
-----

Testing InputSpacebar...Controller should produce an EventPause type Event.
Controller.parseInput()
Controller is parsing an input...
Controller got an InputSpacebar
Controller produced an Event of EventType: EventPause

Testing InputSpeedChange(HIGH)...Controller should produce an EventSpeedChange type event.
Controller.parseInput()
Controller is parsing an input...
Controller got an InputSpeedChange
SpeedChange is an increase: 1
SpeedChange is a decrease: 0
Controller produced an Event of EventType: EventSpeedChange

Testing InputSpeedChange(LOW)...Controller should produce an EventSpeedChange type event.
Controller.parseInput()
Controller is parsing an input...
Controller got an InputSpeedChange
SpeedChange is an increase: 0
SpeedChange is a decrease: 1
Controller produced an Event of EventType: EventSpeedChange

Testing InputSpeedChange(PAUSE)...Controller should produce an EventSpeedChange type event.
Controller.parseInput()
Controller is parsing an input...
Controller got an InputSpeedChange
SpeedChange is an increase: 0
SpeedChange is a decrease: 0
Controller produced an Event of EventType: EventSpeedChange

Testing InputClose...Controller should produce an EventClose.
Controller.parseInput()
Controller is parsing an input...
Controller got an InputClose
Controller produced an Event of EventType: EventClose

unitTestModel() ending...
Press any key to continue...
_
```

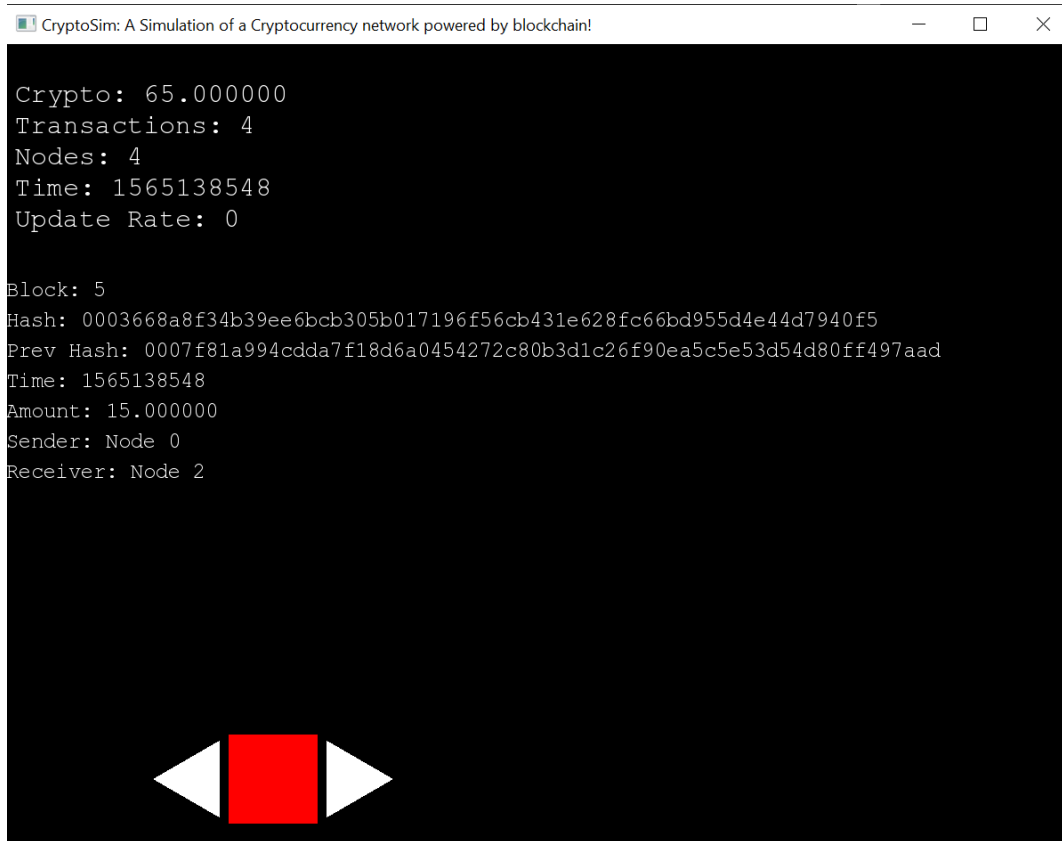
System Testing

Model – Viewer – Controller system

- To pass testing, all acceptance cases must be true:
 1. When the user clicks the square pause button, the Simulation either pauses and the button turns red or it unpauses and the button turns green. If the simulation is paused, no changes to the Model are made.
True
 2. When the user hits the spacebar, the Simulation either pauses and the button turns red or it unpauses and the button turns green. If the simulation is paused, no changes to the Model are made.
True
 3. When the user clicks the left arrow or right arrow buttons to the sides of the pause button, the Simulation modifies its update rate to be either faster (displayed rate decreases in value if right arrow clicked) or slower (displayed rate increase in value if left arrow clicked)
True
 4. When enough time has passed since the last Simulation update and the Sim is not paused, then the Simulation Driver takes an action and the Viewer screen updates accordingly.
True
 5. When the user presses the escape key, the program shuts down.
True
 6. When the user clicks the X in the top right corner of the display window, the program shuts down.
True

Result screenshots on the following pages.

1. Paused state:



2. Running state:



CryptoSim: A Simulation of a Cryptocurrency network powered by blockchain!

```
Crypto: 195.000000
Transactions: 9
Nodes: 6
Time: 3130277245
Update Rate: 0

Block: 10
Hash: 000f2ba5921da55452432f8e41b3ca56077144720fa3e549b362fc4d4ee5cde2
Prev Hash: 000c7430bc393488ce7f4c5acb688ce173de03ff718361eb843d94cf329a6506
Time: 1565138697
Amount: 6.000000
Sender: Node 4
Receiver: Node 0
```

Navigation controls: left arrow, green square, right arrow

3. Sim with Increased Speed:



4. Sim with Decreased Speed:

```
CryptoSim: A Simulation of a Cryptocurrency network powered by blockchain!

Crypto: 1055.000000
Transactions: 20
Nodes: 23
Time: 4695416350
Update Rate: 27

Block: 5
Hash: 000414e669c6c350a0eb083957101a411e5a49a8d40b6e8061a0d2ad09788c25
Prev Hash: 00016367152ad634dd4941915ef1d51a6ad9221207200c34a8cea0983820e133
Time: 1565138969
Amount: 0.000000
Sender: Node 20
Receiver: Node 18
```

