

Question 1: Wal-sys displays the current state of the database contents after you type show_state. Why doesn't the database show studentB?

因为action2还没end，不会写入到database

Question 2: When the database recovers, which accounts should be active, and what values should they contain?

studentA 900, studentC 3100

Question 3: Can you explain why the "DB" file does not contain a record for studentC and contains the pre-debit balance for studentA?

没有必要，DB只要记录最新值就好了，其他如果想知道都可以通过LOG推出来。

Question 4: What do you expect the state of "DB" to be after wal-sys recovers? Why?

studentA 900, studentB 2000, studentC 3100

因为A创建了1000，减了100；B创建了2000；C创建了3000，又加了100

Question 5: Run wal-sys again to recover the database. Examine the "DB" file. Does the state of the database match your expectations? Why or why not?

不，实际上是studentA 900, studentC 3100。因为创建B的action 2没有commit，所以recover的时候只能abort掉。

Question 6: During recovery, wal-sys reports the action_ids of those recoverable actions that are "Losers", "Winners", and "Done". What is the meaning of these categories?

Losers就是在commit之前crash的，采取undo策略的；Winners就是在commit之后end之前crash的，采取redo策略；Done就是在end之后crash的，已经写入数据库了，不用恢复。

Question 7: Why are the results of recoverable action 2's create_account 2 studentB 2000 command not installed in "DB" by the checkpoint command on the following line?

因为2还没commit，如果install了之后后面又改了studentB，这时候crash了，recover的时候log和db就冲突了。而现在不install，从后往前扫描至checkpoint，没有发现commit 2，直接把其中action 2的操作都忽略掉，简单而有效。

Question 8: How many lines were rolled back? What is the advantage of using checkpoints?

6，可以不用roll back checkpoints之前已经结束了的action，只要从后往前扫到checkpoints，而不是从后往前扫整个LOG，大大减少了roll back的量。

Question 9: Does the second run of the recovery procedure (for sequence 2) restore "DB" to the same state as the first run? What is this property called?

是的，幂等性。

Question 10: Compare the action_ids of "Winners", "Losers", and "Done" from the second recovery with those from the first. The lists are different. How does the recovery procedure guarantee the property from Question 9 even though the recovery procedure can change? (Hint: Examine the "LOG" file).

恢复程序会在LOG中把恢复成功（redo了）的action加上end标记，这样下次recover的时候这个action就是winner了，就不会再操作这个action了。

Question 11 (Optional): Wal-sys has a hitherto unmentioned option: if you type wal-sys -undo it will perform undo logging and undo recovery. Try the above sequences again with undo logging to see what changes.

DB中只有studentA的数据，LOG中多了一句把action2标记为Aborted，recover程序action2和action3均被undo，并设为winner。