Controlling access to data (via transactions):

* Data must be protected in the face of system failure
  - goal: resilience
  - approach: logging
* Data must not be corrupted just because
  - several error-free transactions are being executed at the same time
    = concurrency control
    ~ approach: locking

Undo logging:

T does:
A := A+5
B := B×2

S does:
C := C+10

U does:
C := C+10
C := C/2

	time in recovery
<START T>	⇐ nothing
<T, A, 10>	⇐ nothing
<START S>	⇐ nothing
<S, C, 30>	⇐ nothing
<T, B, 20>	⇐ nothing
<COMMIT S>	⇐ do nothing about S
<START U>	⇐ done with U
<U, C, 40> new C=50	⇐ undo U: C := 40
<U, C, 50> new C=25	⇐ undo U: C := 50
<COMMIT T>	⇐ do nothing about T

(1) before recovery starts, what are the values of A, B, C

A = 15
B = 40
C = 40 or 25 or 50

these outputs for Y may or may not have happened

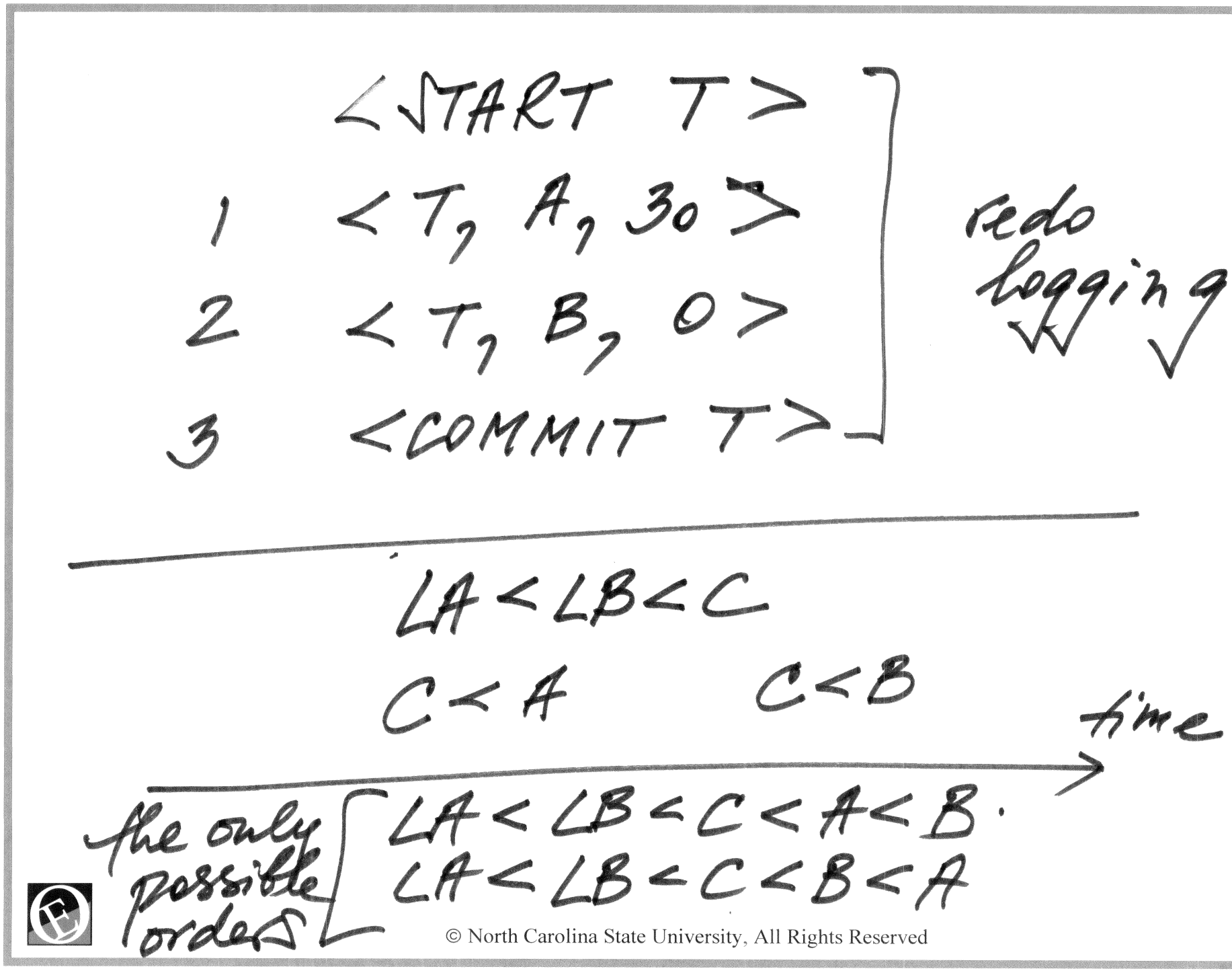
from successful xactions

(2) after recovery is over, what are the values of A, B, C

A = 15

B = 40

C = 40



If, on system crash, we see in log space on disk

(1) <START T>, <T, A, 5>, <T, B, 10>, <COMMIT T>

⇒ xaction must be redone in recovery

(2) <START T>, <T, A, 5>, <T, B, 10>

(or just <START T>, or just <T, A, 5>)

⇒ nothing needs to be done in recovery

Initial values A=B=C=D=E=0

Redo recovery

<START T>

<T, A, 10> (new)

<Start U>

<U, B, 20>

<T, C, 30>

<U, D, 40>

<COMMIT U>

<T, E, 50>

<COMMIT T>

Output(A, 10)

Output(B, 20)

Output(C, 30)

Output(D, 40)

Output(E, 50)

System crash

Recovery

(1) What are the values of A, B, C, D, E after system crash but before recovery?

(2) what are the values of A, B, C, D, E after redo recovery?

Answers:

(1) A = 0 or 10
B = 0 or 20
C = 0 or 30
D = 0 or 40
E = 0 or 50

(2) A = 10
B = 20
C = 30
D = 40
E = 50

Undo	Redo
stores old values	new
outputs of new values happen before commit is flushed	after
Recovery cancels effects of incomplete transactions	Recovery reinforces effects of committed transactions

Undo/redo logging

<START T>

1 <T, A, 10, 20>

2 <T, B, 30, 40>

3 <COMMIT T>

$L_A < L_B < C$

$L_A < A$

$L_B < B$

time →

L_A	A	L_B	B	C.
L_A	L_B	B	A	C
L_A	L_B	C.	A.	B
L_A	L_B	A	C.	B

<START S>
<S, A, 1, 2>
<S, B, 2, 3>
<START T>
<T, C, 4, 5>
<COMMIT T>
<START U>
<U, G, 11, 14>
<U, D, 6, 7>
<S, F, 8, 9>
<COMMIT U>

(1) What are the disk values of A B C D F G after sys crash before recovery?

(2) What are the disk values of A B C D F G after undo/redo recovery?

(1) A = 1 or 2
B = 2 or 3
C = 4 or 5
D = 6 or 7
F = 8 or 9
G = 11 or 14

(2) TO BE CONTINUED