




Transactions

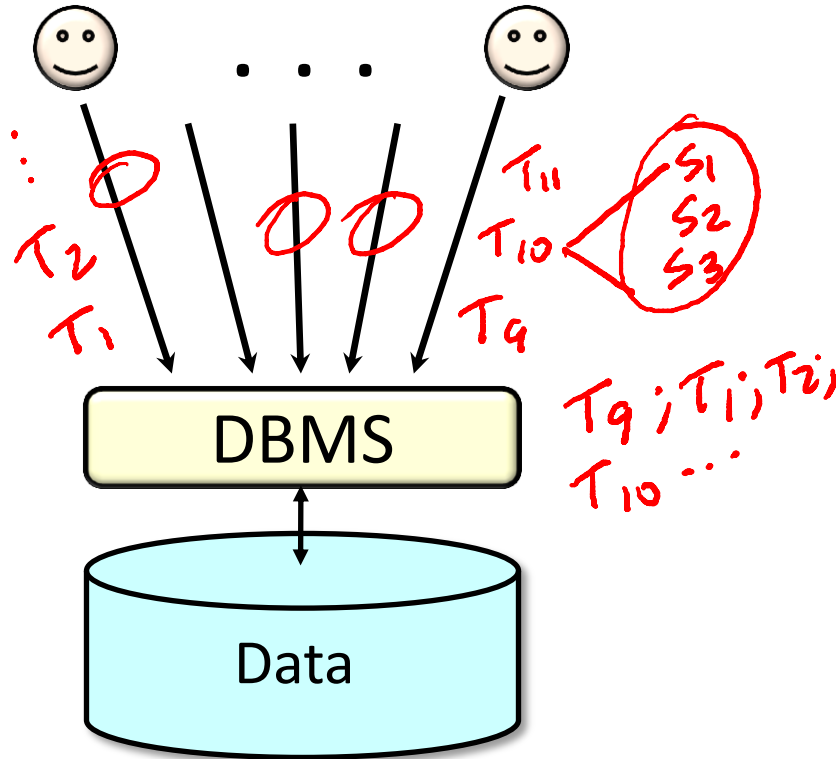
Isolation Levels

Solution for both concurrency and failures

Transactions

A transaction is a sequence of one or more SQL operations treated as a unit

- Transactions appear to run in isolation 
- If the system fails, each transaction's changes are reflected either entirely or not at all

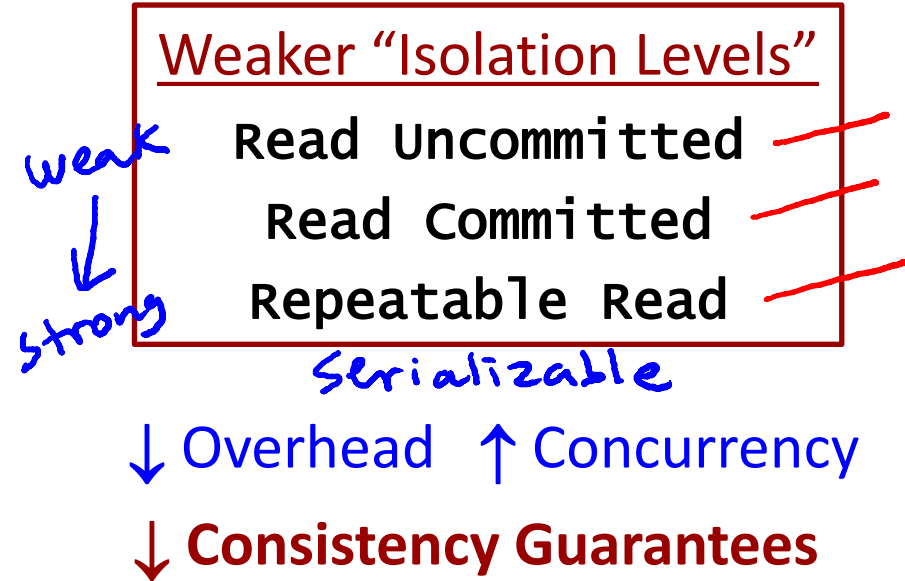
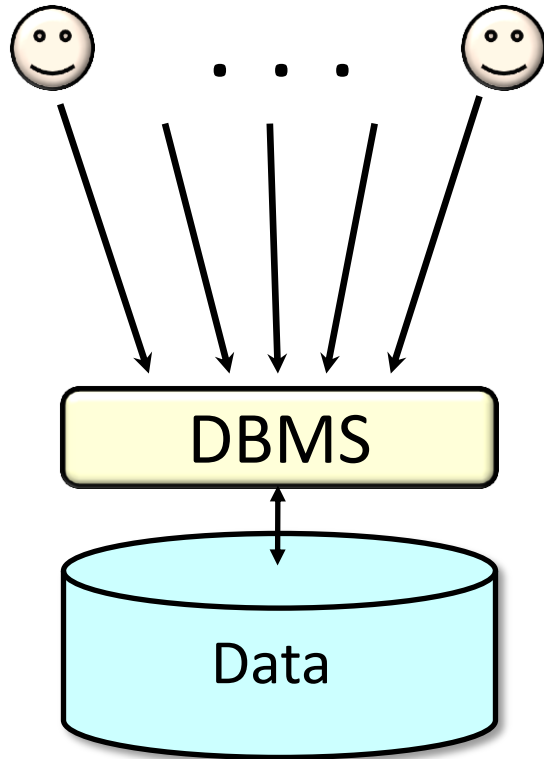
(ACID Properties) **Isolation**Serializability

Operations may be interleaved, but execution must be equivalent to *some* sequential (serial) order of all transactions

⇒ Overhead

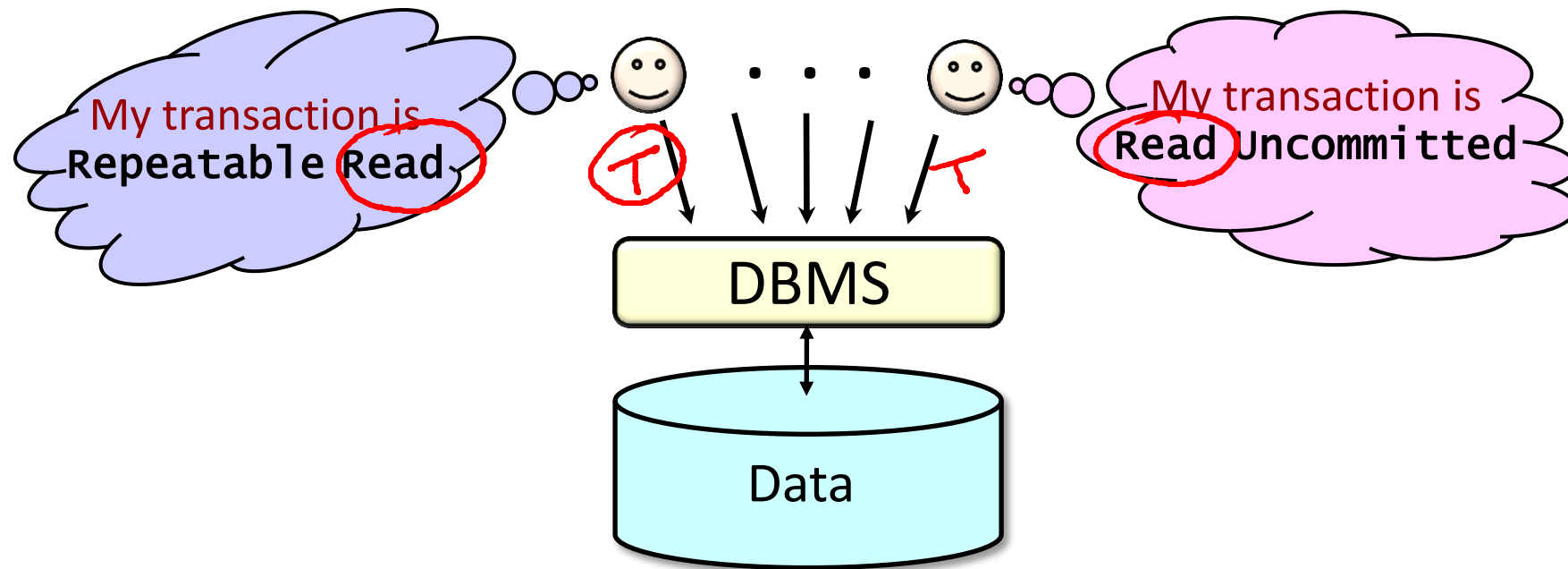
⇒ Reduction in concurrency

(ACID Properties) Isolation



Isolation Levels

- Per transaction
- “In the eye of the beholder”



Dirty Reads

“Dirty” data item: written by an uncommitted transaction

T₁ Update college Set enrollment = enrollment + 1000
where cName = 'Stanford'

concurrent with ...

T₂ Select Avg(enrollment) From college

"dirty"

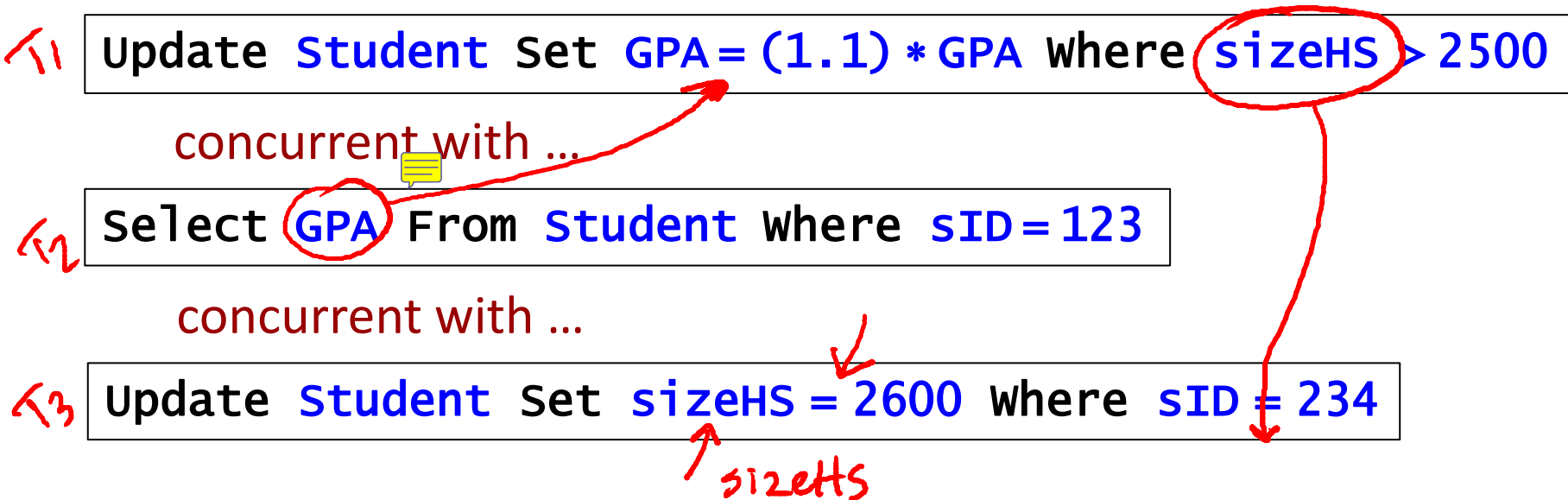
Commit

Commit

Dirty Reads



“Dirty” data item: written by an uncommitted transaction



Isolation Level Read Uncommitted

➤ A transaction may perform dirty reads

T_1 Update Student Set $GPA = (1.1) * GPA$ Where $sizeHS > 2500$

concurrent with...

T_2 Select Avg(GPA) From Student

$T_1; T_2$ ←
 $T_2; T_1$

Isolation Level Read Uncommitted

➤ A transaction may perform dirty reads

T_1 Update Student Set GPA = (1.1) * GPA Where sizeHS > 2500

concurrent with ...

T_2 Set Transaction Isolation Level Read Uncommitted;
Select Avg(GPA) From Student;

$T_1; T_2$ $T_2; T_1$

Isolation Level Read Committed

- A transaction may not perform dirty reads
Still does not guarantee global serializability

T_1 Update **Student** Set $GPA = (1.1) * GPA$ Where **sizeHS** > 2500

concurrent with ...



T_2 Set Transaction Isolation Level Read Committed;
Select Avg(**GPA**) From **Student**; ←
Select Max(**GPA**) From **Student**; ←

$T_1 ; T_2$ $T_2 ; T_1$

Isolation Level Repeatable Read

- A transaction may not perform dirty reads ✓✓
- An item read multiple times cannot change value ✓✓

Still does not guarantee global serializability

T₁

Update Student Set GPA = (1.1) * GPA; ✓
Update Student Set sizeHS = 1500 where sID = 123; ✓

concurrent with ...

T₂

Set Transaction Isolation Level Repeatable Read; ←
Select Avg(GPA) From Student;
Select Avg(sizeHS) From Student;

T₁ ; T₂

T₂ ; T₁

Isolation Level Repeatable Read

- A transaction may not perform dirty reads ✓
- An item read multiple times cannot change value ✓

But a relation can change: “phantom” tuples

T₁ Insert Into Student [100 new tuples]

concurrent with ...

T₂ Set Transaction Isolation Level Repeatable Read;
Select Avg(GPA) From Student;
Select Max(GPA) From Student;

phantom

Avg

Isolation Level Repeatable Read

- A transaction may not perform dirty reads
- An item read multiple times cannot change value

But a relation *can* change: “phantom” tuples

Delete From Student [100 tuples]



concurrent with ..

```
Set Transaction Isolation Level Repeatable Read;  
Select Avg(GPA) From Student;  
Select Max(GPA) From Student;
```




Read Only transactions

- Helps system optimize performance
- Independent of isolation level



```
Set Transaction Read Only;  
Set Transaction Isolation Level Repeatable Read;  
Select Avg(GPA) From Student;  
Select Max(GPA) From Student;
```



Isolation Levels: Summary

	dirty reads	nonrepeatable reads	phantoms
Read Uncommitted	Y	Y	Y
Read Committed	N	Y	Y
Repeatable Read	N	N	Y
Serializable	N	N	N

weak

strong

Isolation Levels: Summary

- Standard default: **serializable**
- Weaker isolation levels
 - Increased concurrency + decreased overhead = increased performance
 - Weaker consistency guarantees
 - Some systems have default **Repeatable Read**
- Isolation level per transaction and “eye of the beholder”
 - Each transaction’s reads must conform to its isolation level