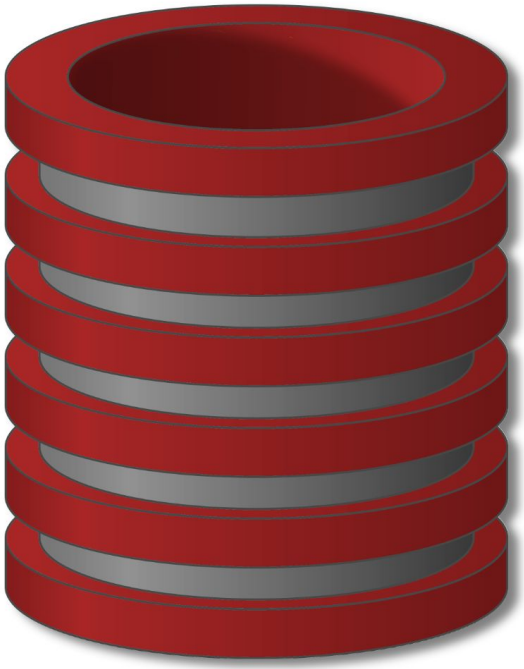


Transactions

Isolation Levels

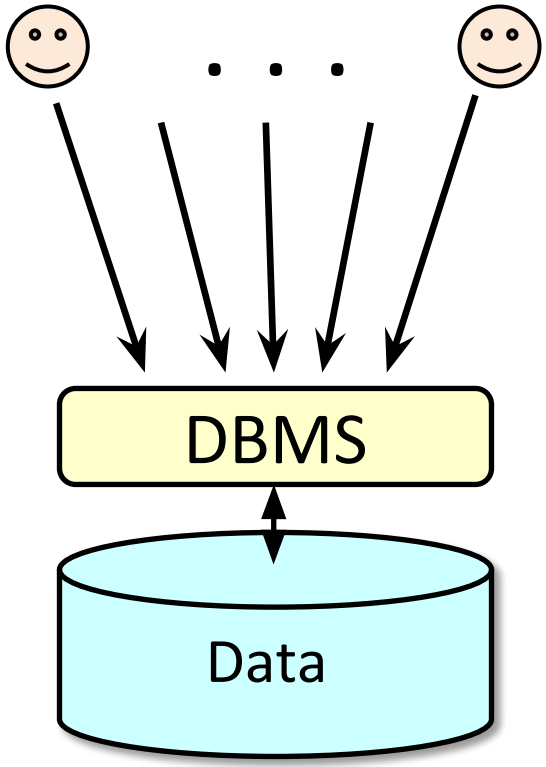
Solution for both concurrency and failures

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**



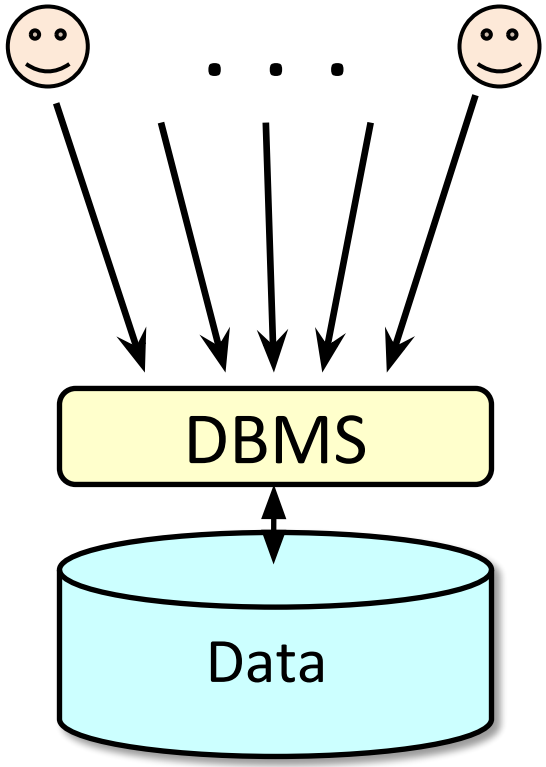
Serializability

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

⇒ Overhead

⇒ Reduction in concurrency

(ACID Properties) **Isolation**



Weaker "Isolation Levels"

Read Uncommitted

Read Committed

Repeatable Read

↓ Overhead

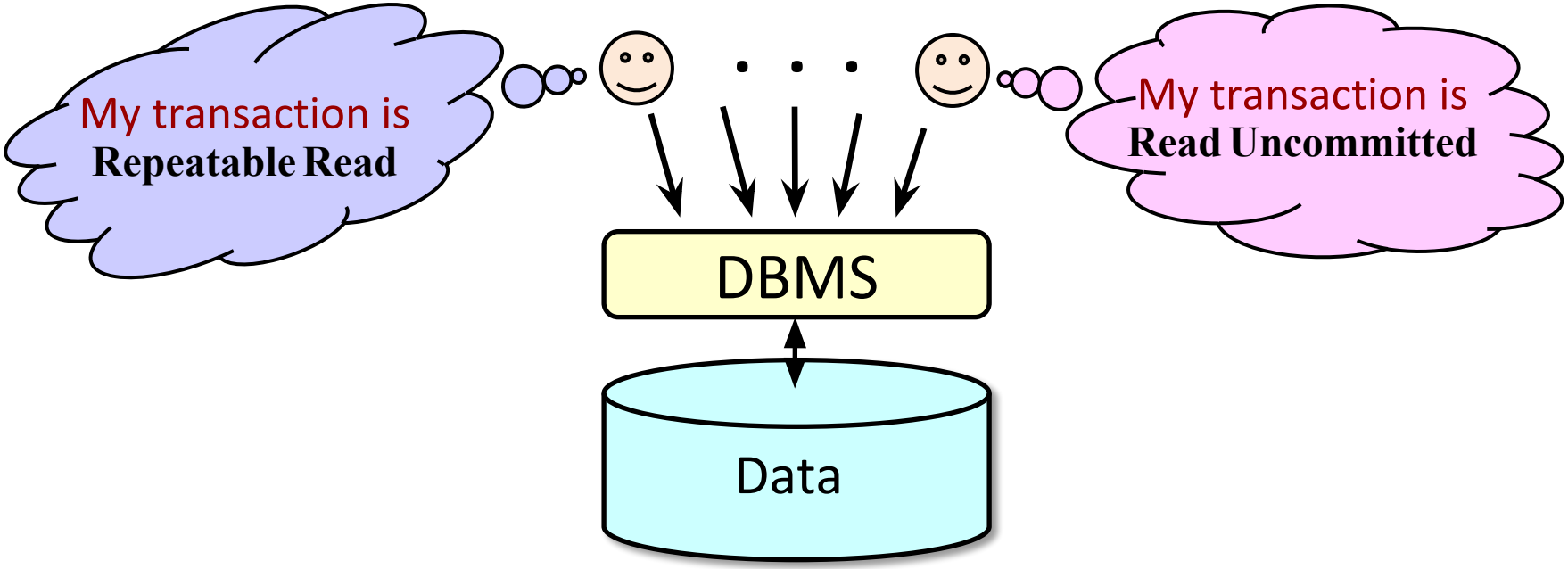
↓ Concurrency

↓ **Guarantees**

↑ **Consistency**

Isolation Levels

- Per transaction
- "In the eye of the beholder"



Dirty Reads

"Dirty" data item: written by an uncommitted transaction

```
Update College Set enrollment = enrollment + 1000
Where cName = 'Stanford'
```

concurrent with …

```
Select Avg(enrollment) From College
```

Dirty Reads

"Dirty" data item: written by an uncommitted transaction

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

concurrent with …

```
Select GPA From Student Where sID = 123
```

concurrent with …

```
Update Student Set sizeHS = 2600 Where sID = 234
```

Transactions

Isolation Level **Read Uncommitted**

- A transaction may perform dirty reads

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

concurrent with …

```
Select Avg(GPA) From Student
```

Isolation Level **Read Uncommitted**

- A transaction may perform dirty reads

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

concurrent with …

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

Isolation Level **Read Committed**

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

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

concurrent with …

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

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

```
Update Student Set GPA = (1.1) * GPA;
Update Student Set sizeHS = 1500 Where sID = 123;
```

concurrent with …

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

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

```
Insert Into Student [ 100 new tuples ]
```

concurrent with …

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

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	Yup	Yup	Yup
Read Committed	No	Yup	Yup
Repeatable Read	No	No	Yup
Serializable	No	No	No

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