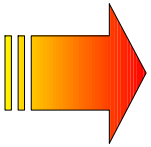
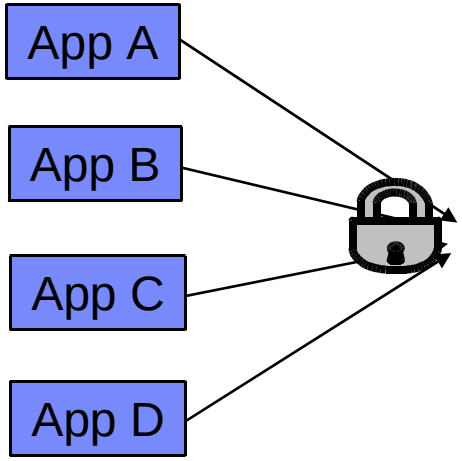
Agenda



- Transactions
- Concurrency & Locking
- Lock Wait
- Deadlocks

Concurrency and Locking



ID	Name	Age
3	Peter	33
5	John	23
22	Mary	22
35	Ann	55

- Concurrency:
  - Multiple users accessing the same resources at the same time
- Locking:
  - Mechanism to ensure data integrity and consistency

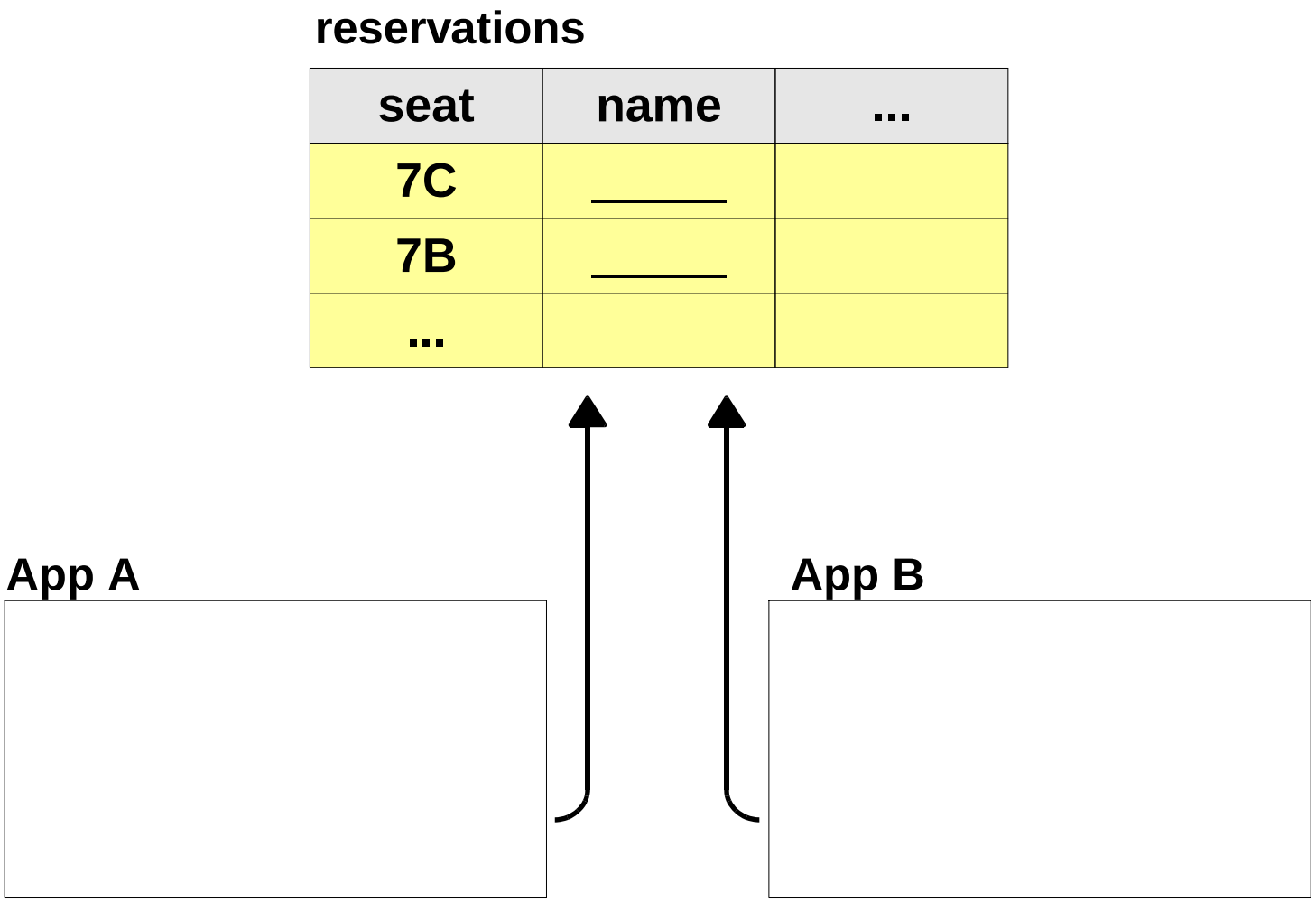
Locking

- Locks are acquired automatically as needed to support a transaction based on “isolation levels”
- COMMIT and ROLLBACK statements release all locks
- Two basic types of locks:
  - Share locks (S locks) – acquired when an application wants to read and prevent others from updating the same row
  - Exclusive locks (X locks) – acquired when an application updates, inserts, or deletes a row

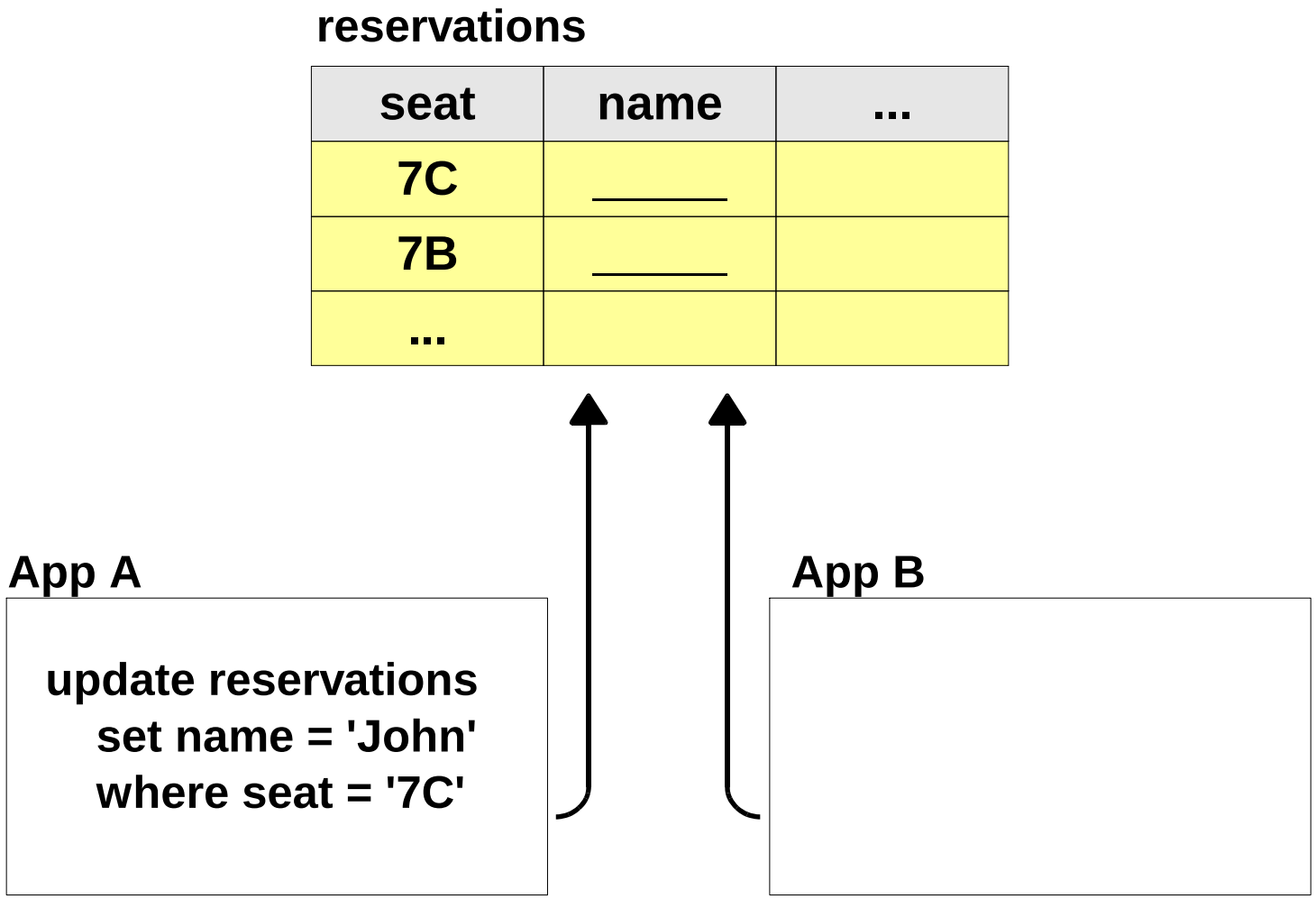
Problems if there is no concurrency control

- Lost update
- Uncommitted read
- Non-repeatable read
- Phantom read

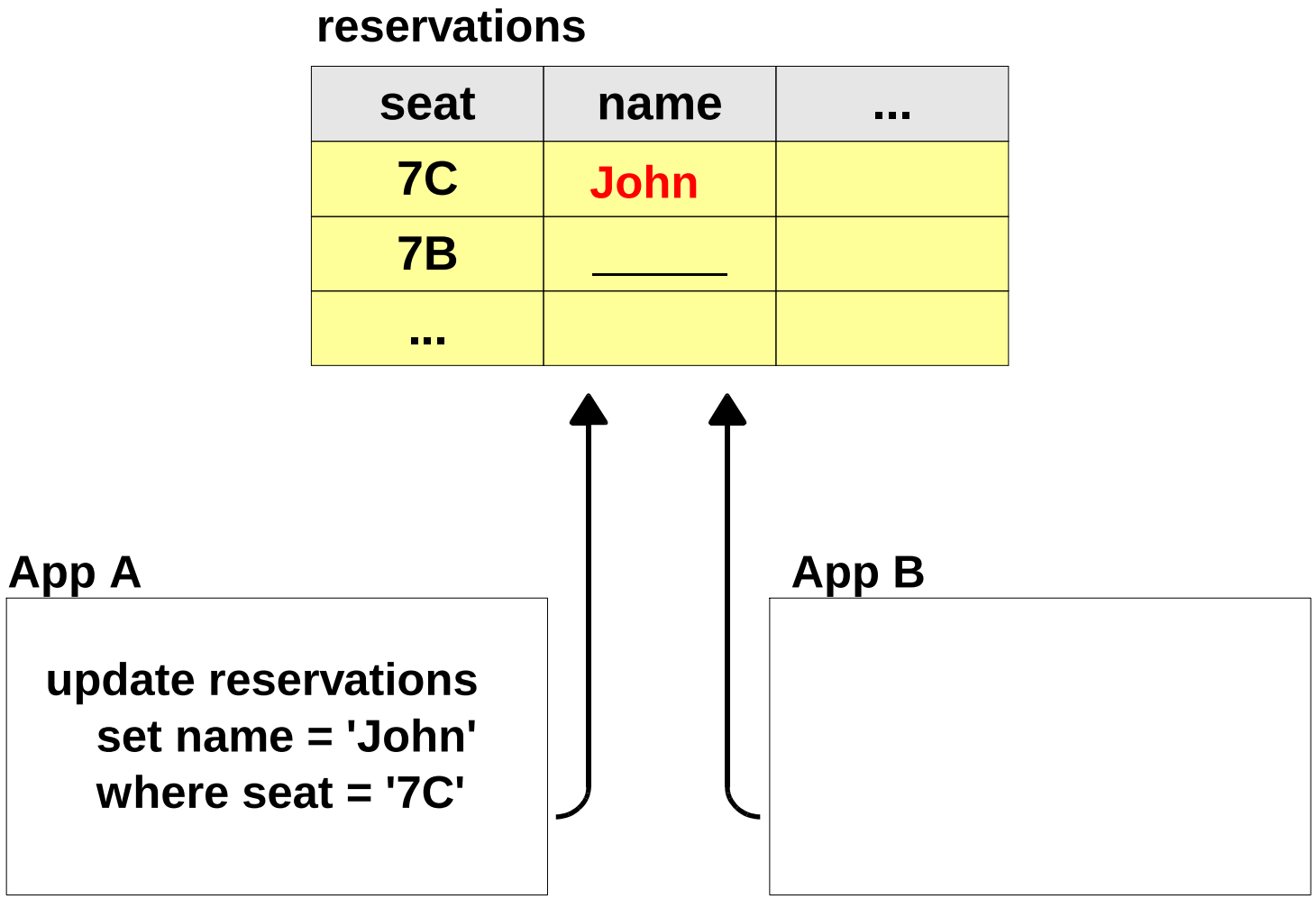
Lost update



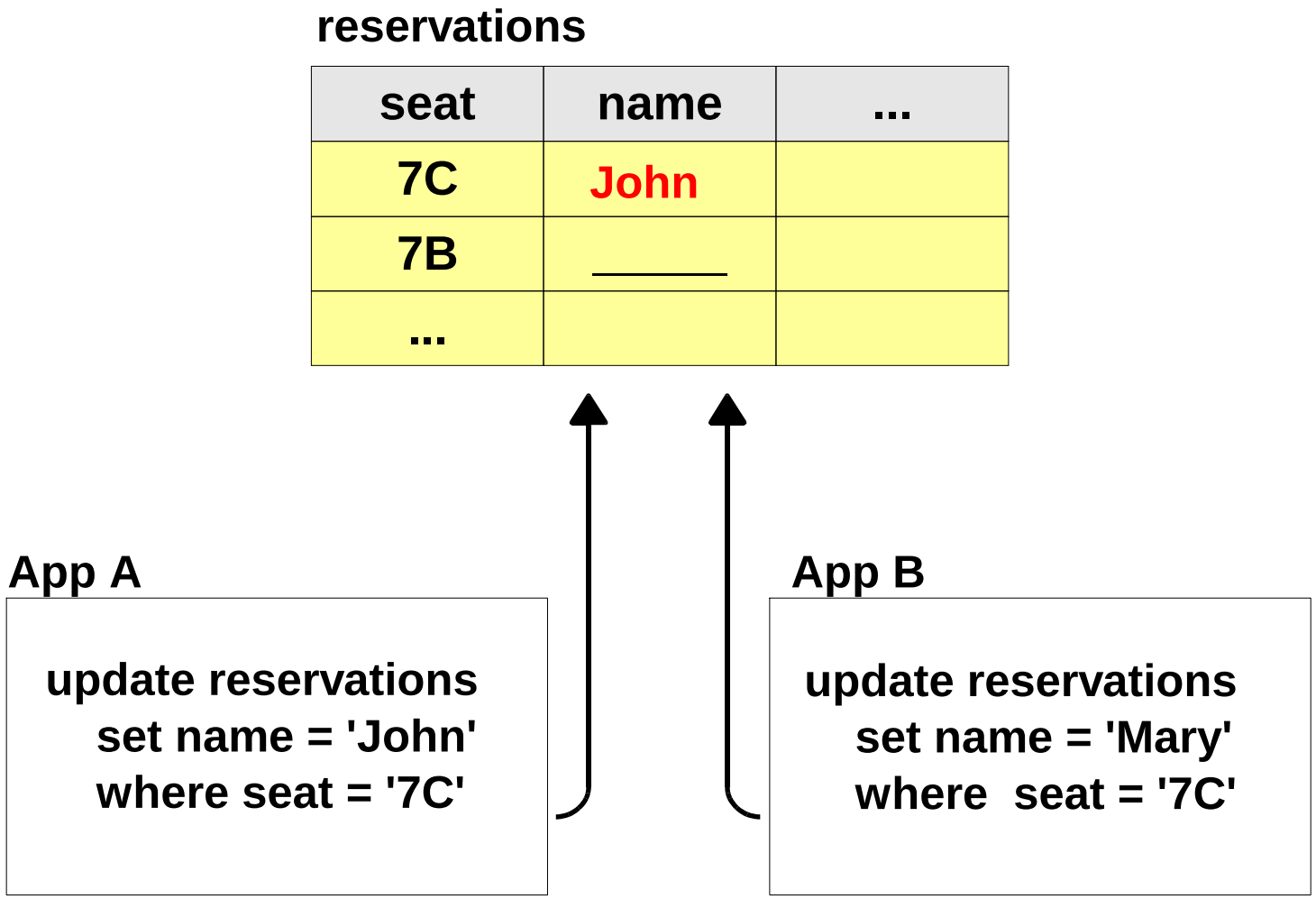
Lost update



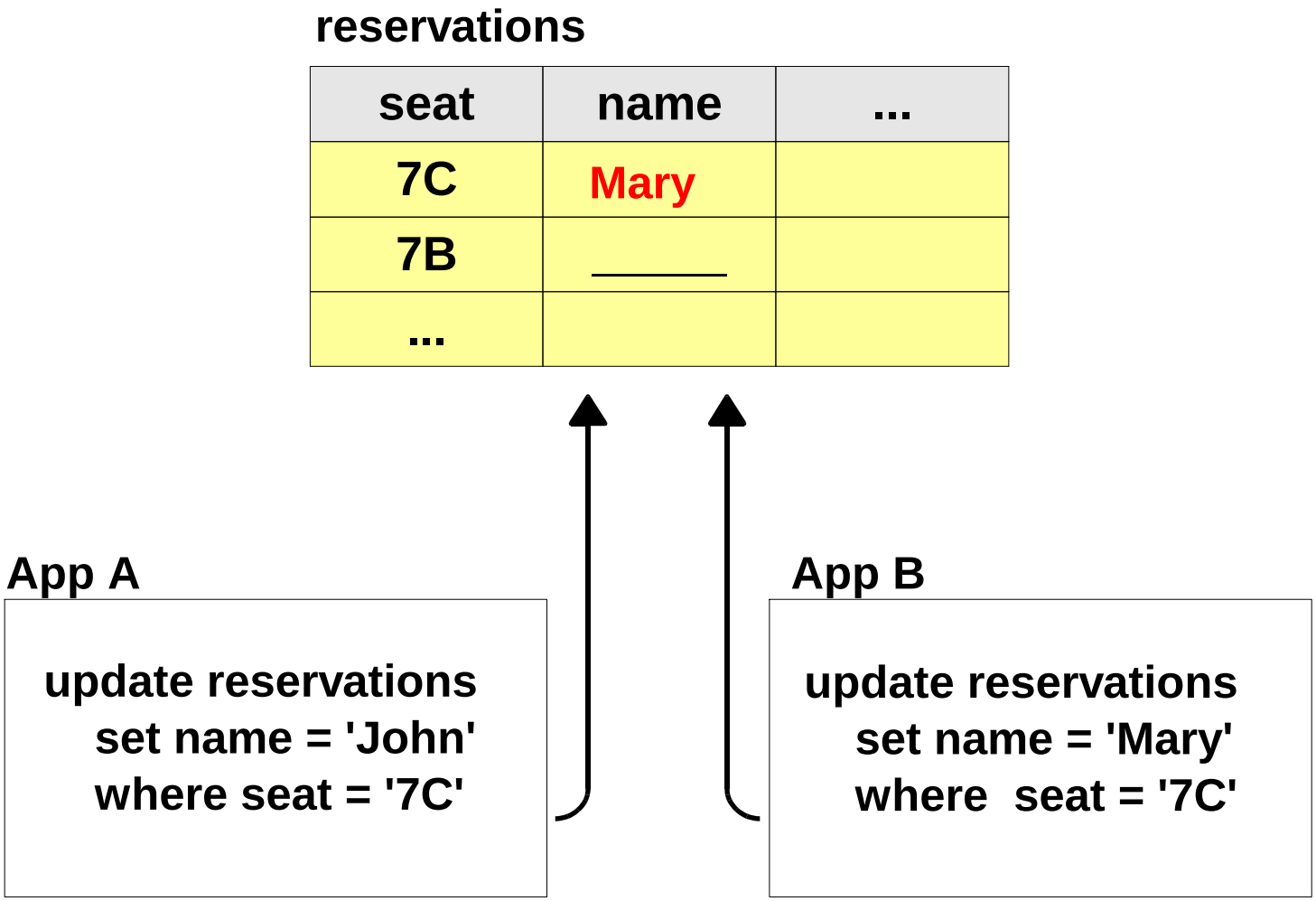
Lost update



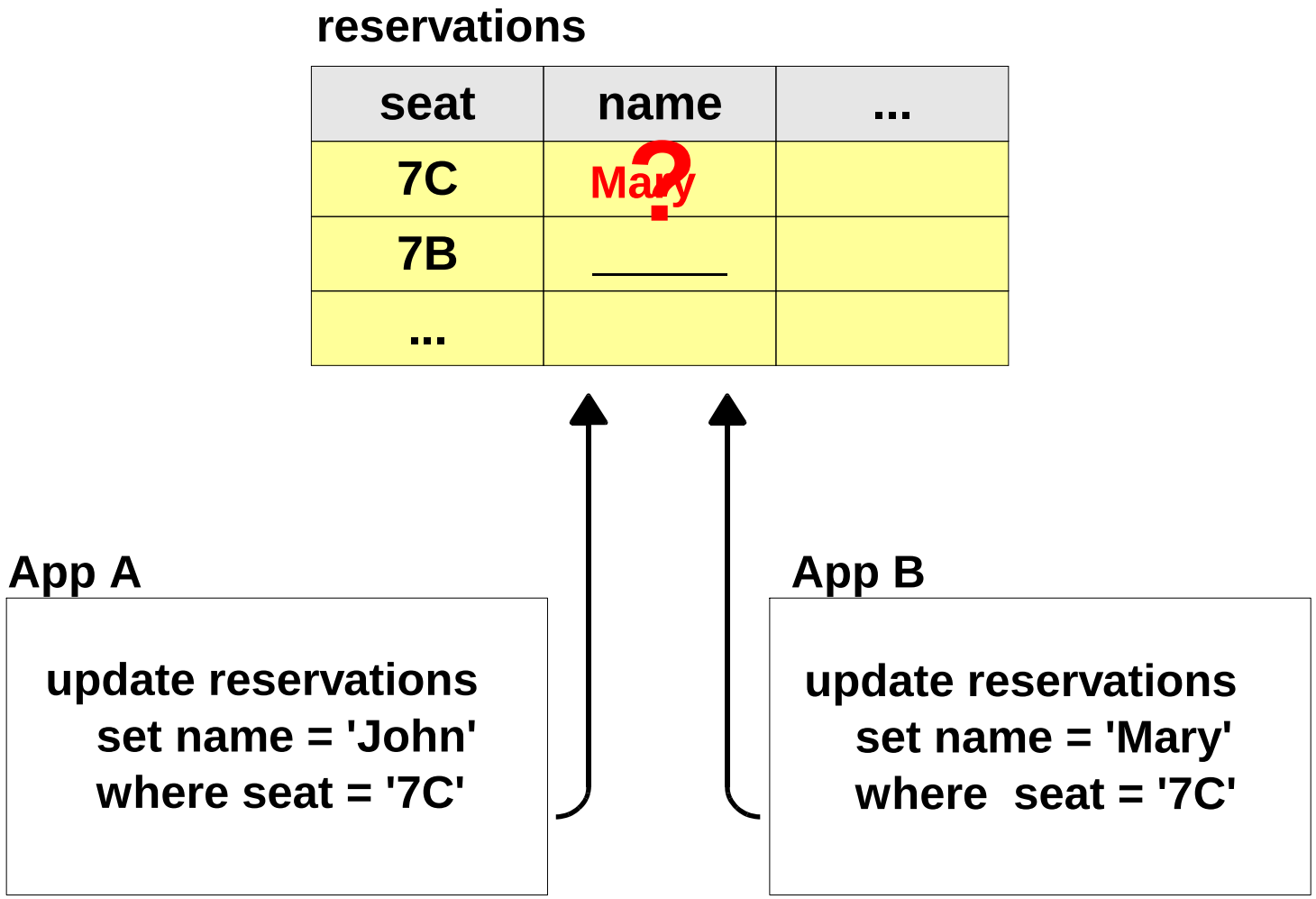
Lost update



Lost update



Lost update



Uncommitted read (also known as “dirty read”)

reservations

seat	name	...
7C	_____	
7B	_____	
...		

App A

App B

Uncommitted read (also known as “dirty read”)

reservations

seat	name	...
7C	_____	
7B	_____	
...		

App A

```
update reservations
    set name = 'John'
    where seat = '7C'
```

App B

Uncommitted read (also known as “dirty read”)

reservations

seat	name	...
7C	John	
7B	_____	
...		

App A

```
update reservations
    set name = 'John'
    where seat = '7C'
```

App B

Uncommitted read (also known as “dirty read”)

reservations

seat	name	...
7C	John	
7B	_____	
...		

App A

```
update reservations
    set name = 'John'
    where seat = '7C'
```

App B

```
Select name
    from reservations
    where seat is '7C'
```

Uncommitted read (also known as “dirty read”)

reservations

seat	name	...
7C	John	
7B	_____	
...		

App A

```
update reservations
    set name = 'John'
    where seat = '7C'
```

App B

```
Select name
    from reservations
    where seat is '7C'
```

John

Uncommitted read (also known as “dirty read”)

reservations

seat	name	...
7C	John	
7B	_____	
...		

App A

```
update reservations
    set name = 'John'
    where seat = '7C'


Roll back
```

App B

```
Select name
    from reservations
    where seat is '7C'
```

John

Uncommitted read (also known as “dirty read”)

reservations

seat	name	...
7C	_____	
7B	_____	
...		

App A

```
update reservations
    set name = 'John'
    where seat = '7C'


Roll back
```

App B

```
Select name
    from reservations
    where seat is '7C'
```

John

Uncommitted read (also known as “dirty read”)

reservations

seat	name	...
7C	_____	
7B	_____	
...		

App A

```
update reservations
   set name = 'John'
   where seat = '7C'

Roll back
```

App B

```
Select name
   from reservations
   where seat is '7C'
```

John

Further processing in App B uses incorrect / uncommitted value of “John”

Non-repeatable read

reservations

seat	name	...
7C	_____	
7B	_____	
...		

App A

App B

Non-repeatable read

reservations

seat	name	...
7C	_____	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL
```

App B

Non-repeatable read

reservations

seat	name	...
7C	_____	
7B	_____	
...		

7C

7B

App A

```
select seat
  from  reservations
  where name is NULL
```

App B

Non-repeatable read

reservations

seat	name	...
7C	_____	
7B	_____	
...		

7C

7B

App A

```
select seat
  from  reservations
  where name is NULL
```

App B

```
update reservations
    set name = 'John'
    where seat = '7C'
```

Non-repeatable read

reservations

seat	name	...
7C	John	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL
```

App B

```
update reservations
    set name = 'John'
    where seat = '7C'
```

7C

7B

Non-repeatable read

reservations

seat	name	...
7C	John	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL

  ...
select seat
  from  reservations
  where name is NULL
```

App B

```
update reservations
    set name = 'John'
    where seat = '7C'
```

7C

7B

Non-repeatable read

reservations

seat	name	...
7C	John	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL

  ...
select seat
  from  reservations
  where name is NULL
```

7C

7B

7B

App B

```
update reservations
    set name = 'John'
    where seat = '7C'
```

Non-repeatable read

reservations

seat	name	...
7C	John	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL

  ...
select seat
  from  reservations
  where name is NULL
```

App B

```
update reservations
    set name = 'John'
    where seat = '7C'
```

7C

7B

7B

The same SELECT (read) returns a different result: Less rows (in this case '7C' doesn't show anymore). This is a non-repeatable read

Phantom read

reservations

seat	name	...
7C	Susan	
7B	_____	
...		

App A

App B

Phantom read

reservations

seat	name	...
7C	Susan	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL
```

App B

Phantom read

reservations

seat	name	...
7C	Susan	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL
```

App B

7B

Phantom read

reservations

seat	name	...
7C	Susan	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL
```

7B

App B

```
update reservations
    set name = NULL
    where seat = '7C'
```

Phantom read

reservations

seat	name	...
7C	_____	
7B	_____	
...		

7B

App A

```
select seat
  from  reservations
  where name is NULL
```

App B

```
update reservations
    set name = NULL
    where seat = '7C'
```

Phantom read

reservations

seat	name	...
7C	_____	
7B	_____	
...		

7B

App A

```
select seat
  from  reservations
  where name is NULL

  ...
select seat
  from  reservations
  where name is NULL
```

App B

```
update reservations
    set name = NULL
    where seat = '7C'
```

Phantom read

reservations

seat	name	...
7C	_____	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL

  ...
select seat
  from  reservations
  where name is NULL
```

App B

```
update reservations
    set name = NULL
    where seat = '7C'
```

7B

7C

7B

Phantom read

reservations

seat	name	...
7C	_____	
7B	_____	
...		

App A

```
select seat
  from  reservations
  where name is NULL

  ...
select seat
  from  reservations
  where name is NULL
```

App B

```
update reservations
    set name = NULL
    where seat = '7C'
```

7B

7C

7B

The same SELECT (read) returns a different result: More rows (phantom rows, in this case '7C', is shown)
This is a phantom read