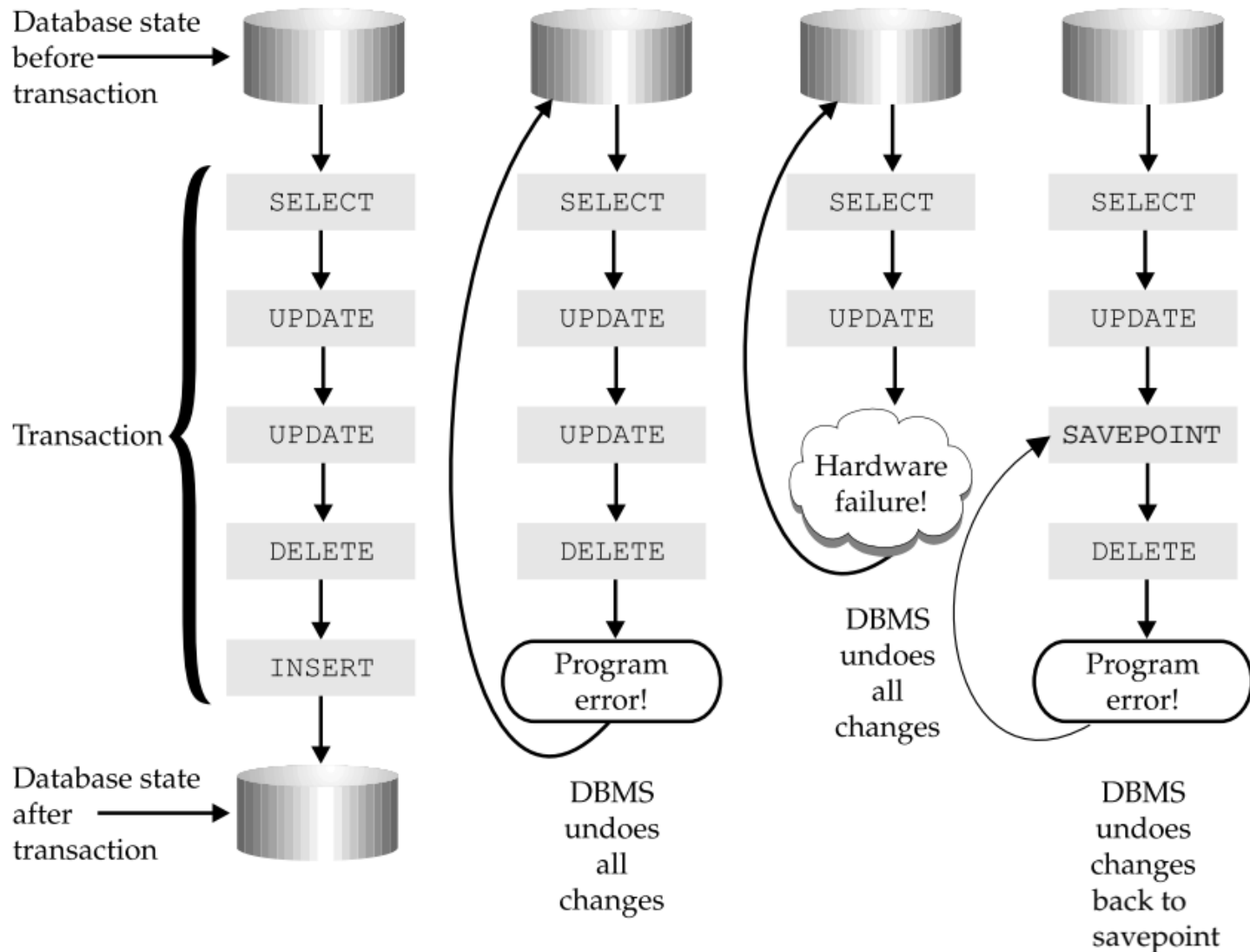


Database Recovery

November 10, 2023

Remember Transaction



Database Recovery

† In the event of system failure, that database must be restored to a usable state as soon as possible to what it was when the system crashed.

† Two recovery techniques:

- Recovery via **reprocessing**
- Recovery via **rollback/rollforward**

Recovery via Reprocessing

- † The database goes back to a known point (database save) and reprocesses the workload from there
- † Make a copy periodically of the DB (database save) and to keep a record of all transactions that have been processed since the save
- † Restore DB from the save and reprocess all transactions
- † Unfeasible strategy because
 - The recovered system may never catch up if the computer is heavily scheduled
 - Asynchronous events, although concurrent transactions, may cause different results

Recovery via Rollback/Rollforward

- † Periodically save the database and keep a database change log since the save
 - Database log contains records of the data changes in chronological order
- † Requirement: a log of the transaction results
- † **Log** contains records of data changes in chronological order
- † Transactions must be written to the log before they are applied to the database (imp point)
- † One of the 2 methods can be followed in case of failure

Recovery via Rollback/Rollforward

† Rollforward:

- the database is restored using the saved data, and all valid transactions since the save are reapplied
- remember transactions are not reprocessed, but processed changes, as recorded in the log, are reapplied

† Rollback:

- undo the changes made by erroneous or partially processed transaction by undoing the changes they have made in the DB, and
- Restart valid transactions that were in the process at the time of the failure

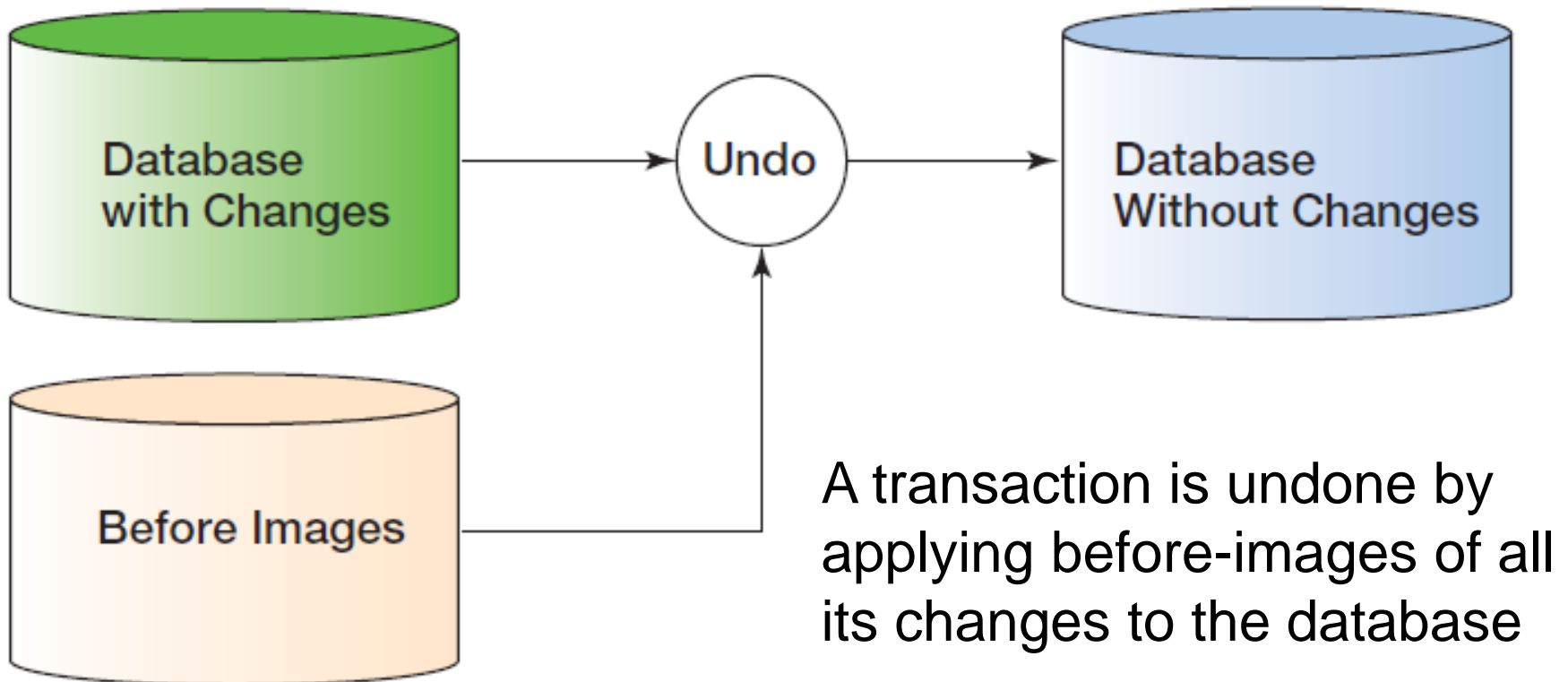
Recovery via Rollback/Rollforward

- † Requirement: a log of the transaction results to be kept, which contains records of data changes in chronological order
- † Transactions must be written to the log before they are applied to the database (imp point)
- † In the event of failure, the log is used both to **undo** (removing changes in the database) and to **redo** (reapplying changes in the database) transactions

Rollback

Before-image: a copy of every database record (or page) before it was changed.

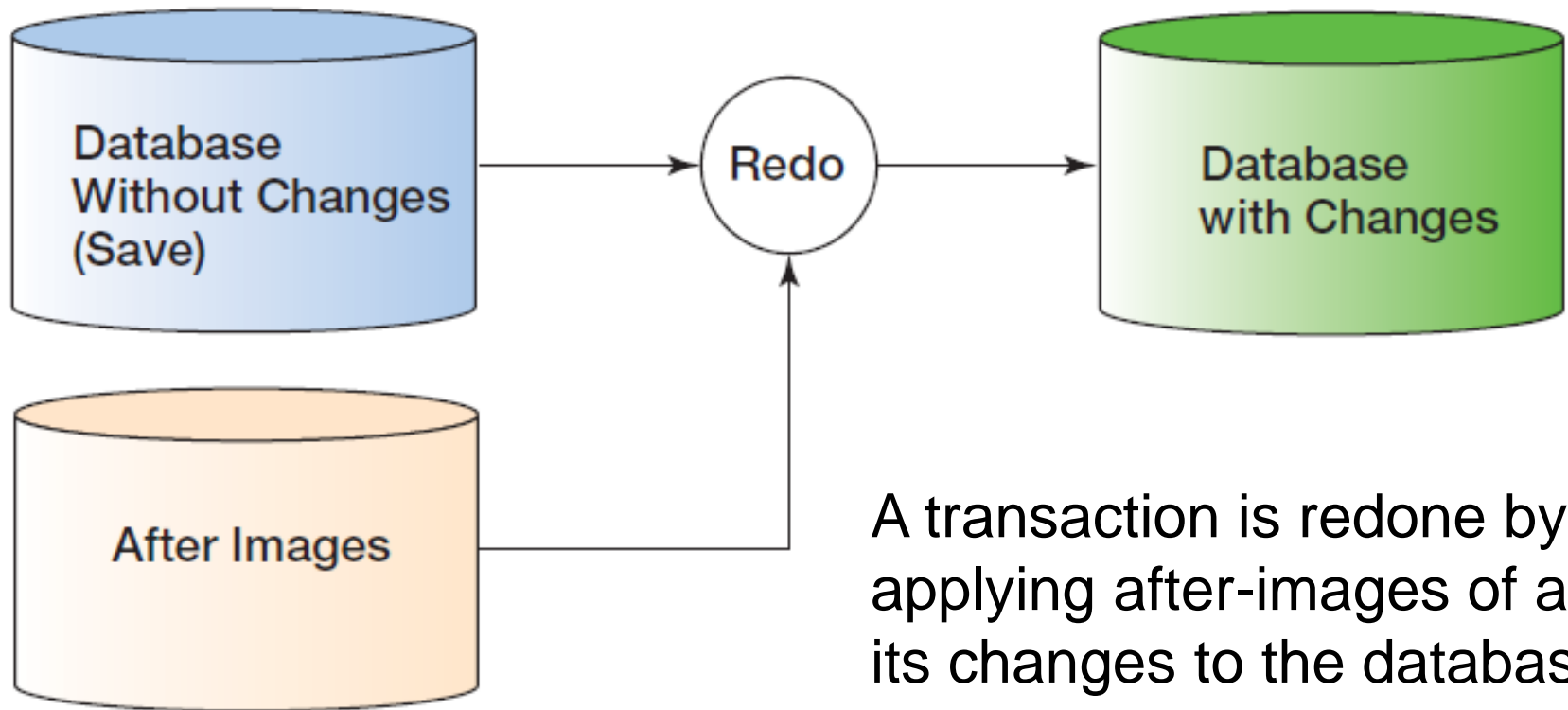
Undo changes made by erroneous/partially processed transaction



Rollforward

After-image: a copy of every database record (or page) after it was changed

Reapplying changes in the DB



A transaction is redone by applying after-images of all its changes to the database.

Transaction Log

Transaction ID

Reverse Pointer

Forward Pointer

Time

Type of Operation

Object

Before-Image

After-Image

Relative Record Number

1	OT1	0	2	11:42	START			
2	OT1	1	4	11:43	MODIFY	CUST 100	(old value)	(new value)
3	OT2	0	8	11:46	START			
4	OT1	2	5	11:47	MODIFY	SP AA	(old value)	(new value)
5	OT1	4	7	11:47	INSERT	ORDER 11		(value)
6	OT3	0	9	11:48	START			
7	OT1	5	0	11:49	COMMIT			
8	OT2	3	0	11:50	COMMIT			
9	OT3	6	10	11:51	MODIFY	SPBB	(old value)	(new value)
10	OT3	9	0	11:51	COMMIT			

Transaction Log

Given a log with before images and after images, the undo and redo actions are straightforward.

1	OT1	0	2	11:42	START			
2	OT1	1	4	11:43	MODIFY	CUST 100	(old value)	(new value)
3	OT2	0	8	11:46	START			
4	OT1	2	5	11:47	MODIFY	SP AA	(old value)	(new value)
5	OT1	4	7	11:47	INSERT	ORDER 11		(value)
6	OT3	0	9	11:48	START			
7	OT1	5	0	11:49	COMMIT			
8	OT2	3	0	11:50	COMMIT			
9	OT3	6	10	11:51	MODIFY	SPBB	(old value)	(new value)
10	OT3	9	0	11:51	COMMIT			

A Recovery Strategy: An Example

Accept order data from browser.
Read CUSTOMER and SALESPERSON records.
Change CUSTOMER and SALESPERSON records.
Rewrite CUSTOMER record. } (Log records
Rewrite SALESPERSON record. } written here)
Insert new ORDER record.

****CRASH****

ORDER Transaction

Before-images of
Customer and
salesperson records

DB with new CUSTOMER,
SALESPERSON and
ORDER records

Recovery Processor
(applies before-images of CUSTOMER and
SALESPERSON and removes new ORDER record)

DB with ORDER
transaction removed

Recovery Processing to UNDO
an ORDER Transaction

Checkpoint

- † Restoring a DB to its most recent save and reapplying all transactions may require considerable processing
- † Use of checkpoints by DBMS products
- † A **checkpoint** is a point of synchronization between the database and the transaction log
- † Checkpoints speed up database recovery process
- † Most DBMS products automatically checkpoint themselves

Managing the DBMS

† DBA's Responsibilities

- Generate database application performance reports
- Investigate user performance complaints
- Assess need for changes in database structure or application design
- Modify database structure
- Evaluate and implement new DBMS features
- Tune the DBMS

Maintaining the Data Repository

- † DBA: responsible for maintaining data repository also
- † **Data repositories** are collections of metadata about users, databases, and its applications
- † The repository may be
 - Virtual as it is composed of metadata from many different sources: DBMS, code libraries, Web page generation and editing tools, etc., or
 - An integrated product from a CASE tool vendor or from other companies such as Oracle
- † The best repositories are active and they are part of the system development process