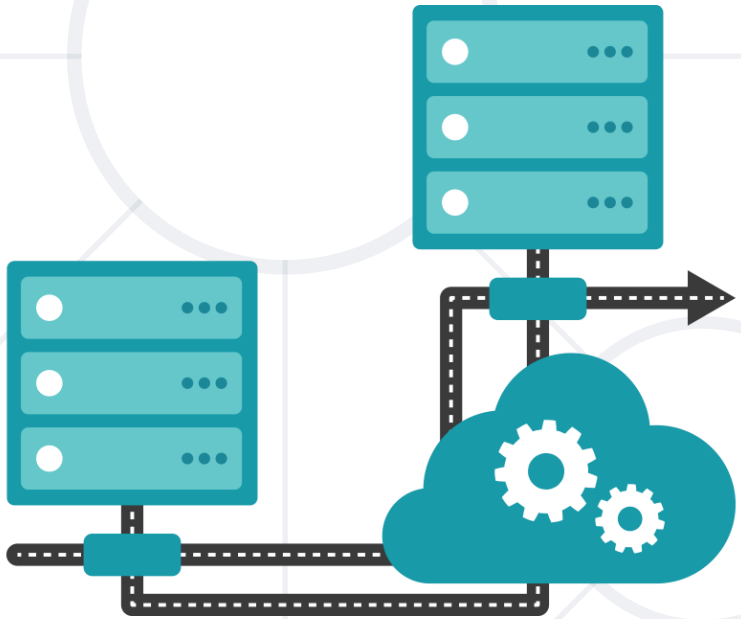
Database Programmability

User-defined Functions, Procedures, Triggers and Transactions



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#Java-DB

User-Defined Functions

Encapsulating Custom Logic

User-Defined Functions

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- Extend the functionality of a MySQL Server
  - Modular programming – write **once**, call it **any number** of times
  - Faster execution – doesn't need to be reparsed and reoptimized with each use
  - Break out complex logic into **shorter code blocks**
- Functions can be:
  - Scalar – return **single value** or **NULL**
  - Table-Valued – return a **table**

Problem: Count Employees by Town

- Write a function **ufn_count_employees_by_town(town_name)** that:
  - Accepts town name as a parameter
  - Returns the count of employees in the database who live in that town

Solution: Count Employees by Town

```
CREATE FUNCTION ufn_count_employees_by_town(town_name VARCHAR(20))
RETURNS INT
DETERMINISTIC
BEGIN
        DECLARE e_count INT;
        SET e_count := (SELECT COUNT(employee_id) FROM employees AS e
         JOIN addresses AS a ON a.address_id = e.address_id
         JOIN towns AS t ON t.town_id = a.town_id
        WHERE t.name = town_name);
        RETURN e_count;
END
```

Function Name

Function Logic

Result: Count Employees by Town

- Examples of expected output:

Function Call

Employees count

```
SELECT ufn_count_employees_by_town('Sofia');
```

3

```
SELECT ufn_count_employees_by_town('Berlin');
```

1

```
SELECT ufn_count_employees_by_town(NULL);
```

0

Stored Procedures

Sets of Queries Stored On DB Server

Stored Procedures

- Stored procedures are **logic** removed from the application and placed **on the database server**
  - Can greatly cut down traffic on the network
  - Improve the security of the database server
  - Separate data access routines from the business logic
- Stored procedures are accessed by programs using different platforms and API's.

Creating Stored Procedures

- CREATE PROCEDURE
- Example:

```
DELIMITER $$
CREATE PROCEDURE usp_select_employees_by_seniority()
BEGIN
  SELECT *
  FROM employees
  WHERE ROUND((DATEDIFF(NOW(), hire_date) / 365.25)) < 15;
END $$
```

Procedure Name

Procedure Logic

Executing and Dropping Stored Procedures

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- Executing a stored procedure by **CALL**

```
CALL usp_select_employees_by_seniority();
```

- **DROP** PROCEDURE

```
DROP PROCEDURE usp_select_employees_by_seniority;
```

Defining Parameterized Procedures

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- To define a parameterized procedure use the syntax:

```
CREATE PROCEDURE usp_procedure_name
(parameter_1_name parameter_type,
parameter_2_name parameter_type,…)
```

Parameterized Stored Procedures – Example

Procedure Name

```
DELIMITER $$
CREATE PROCEDURE usp_select_employees_by_seniority(min_years_at_work INT)
BEGIN
  SELECT first_name, last_name, hire_date,
    ROUND(DATEDIFF(NOW(),DATE(hire_date)) / 365.25,0) AS 'years'
  FROM employees
  WHERE ROUND(DATEDIFF(NOW(),DATE(hire_date)) / 365.25,0) > min_years_at_
work
  ORDER BY hire_date;
END $$
```

Procedure Logic

Usage

```
CALL usp_select_employees_by_seniority(15);
```

Returning Values Using OUTPUT Parameters

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```
CREATE PROCEDURE usp_add_numbers
(first_number INT,
second_number INT,
   OUT result INT)
BEGIN
   SET result = first_number + second_number;
END $$
DELIMITER ;
SET @answer=0;
CALL usp_add_numbers(5, 6,@answer);
SELECT @answer;
```

Creating procedure

Executing procedure

@answer
11

Display results

Problem: Employees Promotion

- Write a stored procedure that raises employees salaries by department name (as parameter) by 5%
  - Use soft_uni database

employee_id	first_name	last_name	middle_name	job_title	department_id
150	Stephanie	Conroy	A	Network Manager	11
268	Stephen	Jiang	Y	North American Sales Manager	3
288	Syed	Abbas	E	Pacific Sales Manager	3
21	Peter	Krebs	J	Production Control Manager	8

Solution: Employees Promotion

```
CREATE PROCEDURE usp_raise_salaries(department_name varchar(50))
BEGIN
        UPDATE employees AS e
         JOIN departments AS d
        ON e.department_id = d.department_id
        SET salary = salary * 1.05
        WHERE d.name = department_name;
END
```

Result: Employees Promotion

- Procedure result for 'Sales' department:

```
CALL usp_raise_salaries('Sales');
```

Data before procedure call:

employee_id	salary
268	48 100.00
273	72 100.00
…	…

Data after procedure call:

employee_id	salary
268	50 505.00
273	75 705.00
…	…

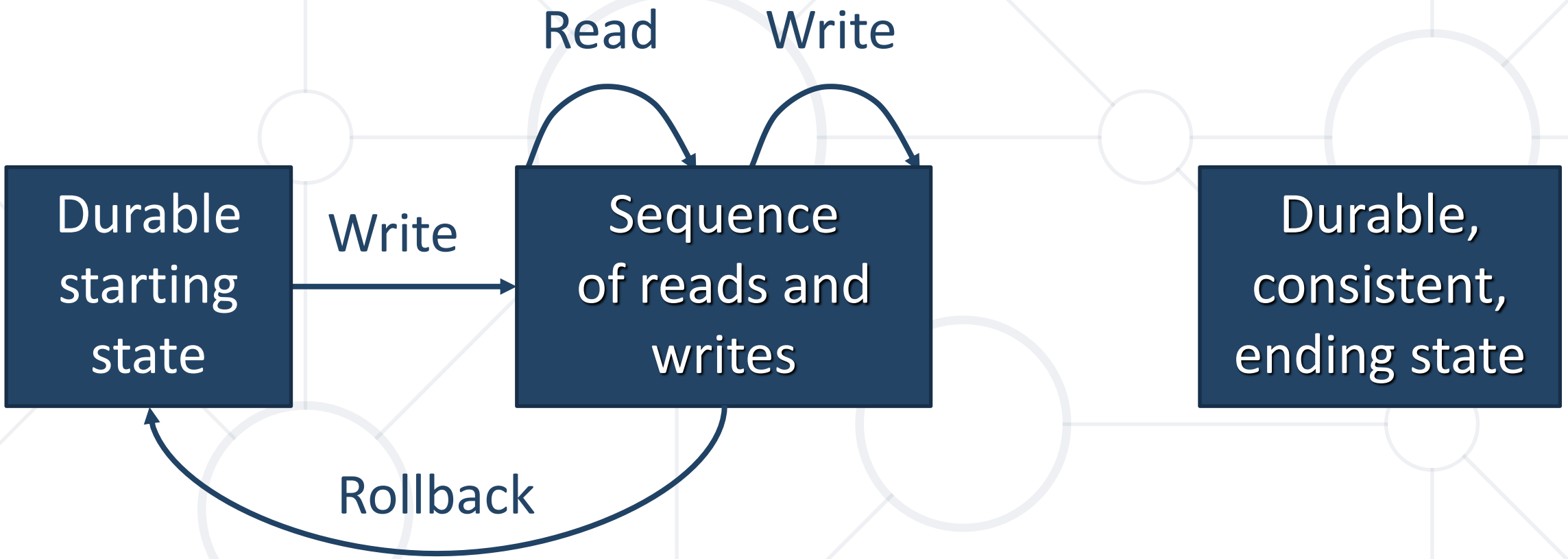
What is a Transaction?

Executing Operations As a Whole

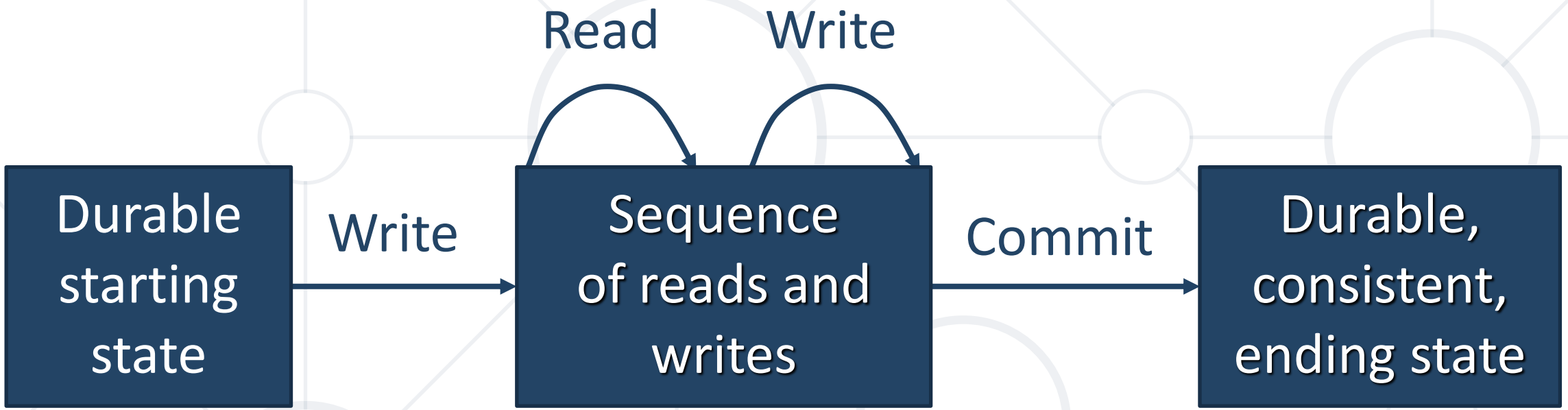
Transactions

- Transaction is a **sequence of actions** (database operations) executed as a whole
  - Either **all** of them complete successfully or **none** of the them
- Example of transaction
  - A bank transfer from one account into another (withdrawal + deposit)
    - If either the withdrawal or the deposit fails **the whole operation is cancelled**

Transactions: Lifecycle (Rollback)



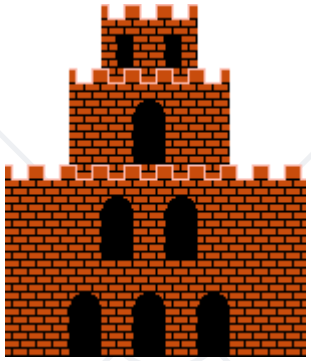
Transactions: Lifecycle (Commit)



Transactions Behavior

- Transactions guarantee the **consistency** and the **integrity** of the database.
  - All changes in a transaction are temporary
  - Changes are persisted when `COMMIT` is executed
  - At any time all changes can be canceled by `ROLLBACK`
- All of the operations are executed as a whole.

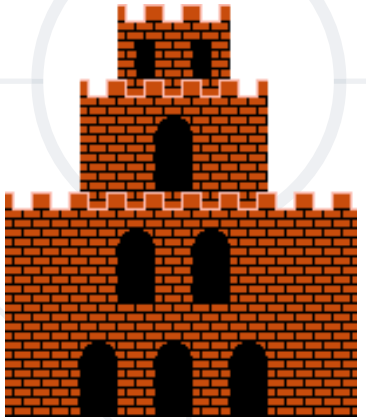
Checkpoints in Games



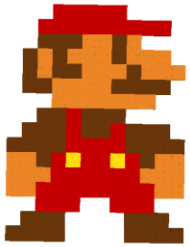
Castle 1-1

DIE

SURVIVE



Castle 1-2



Mario

What Are Transactions?

STATE 1

ROLLBACK

COMMIT

STATE 2

Queries

Problem: Employees Promotion by ID

- Write a transaction that raises an employee's salary by id only if the employee exists in the database
  - If not, no changes should be made
  - Use soft_uni database

Solution: Employees Promotion

```
CREATE PROCEDURE usp_raise_salary_by_id(id int)
BEGIN
        START TRANSACTION;
        IF((SELECT count(employee_id) FROM employees WHERE employee_id
like id)<>1) THEN
        ROLLBACK;
        ELSE
                UPDATE employees AS e SET salary = salary + salary*0.05
                WHERE e.employee_id = id;
        END IF;
END
```

Transactions Properties

- Modern DBMS servers have built-in transaction support
  - Implement "ACID" transactions
  - E.g. Oracle, MySQL, MS SQL Server, …
- ACID means:
  - **A**tomicity
  - **C**onsistency
  - **I**solation
  - **D**urability

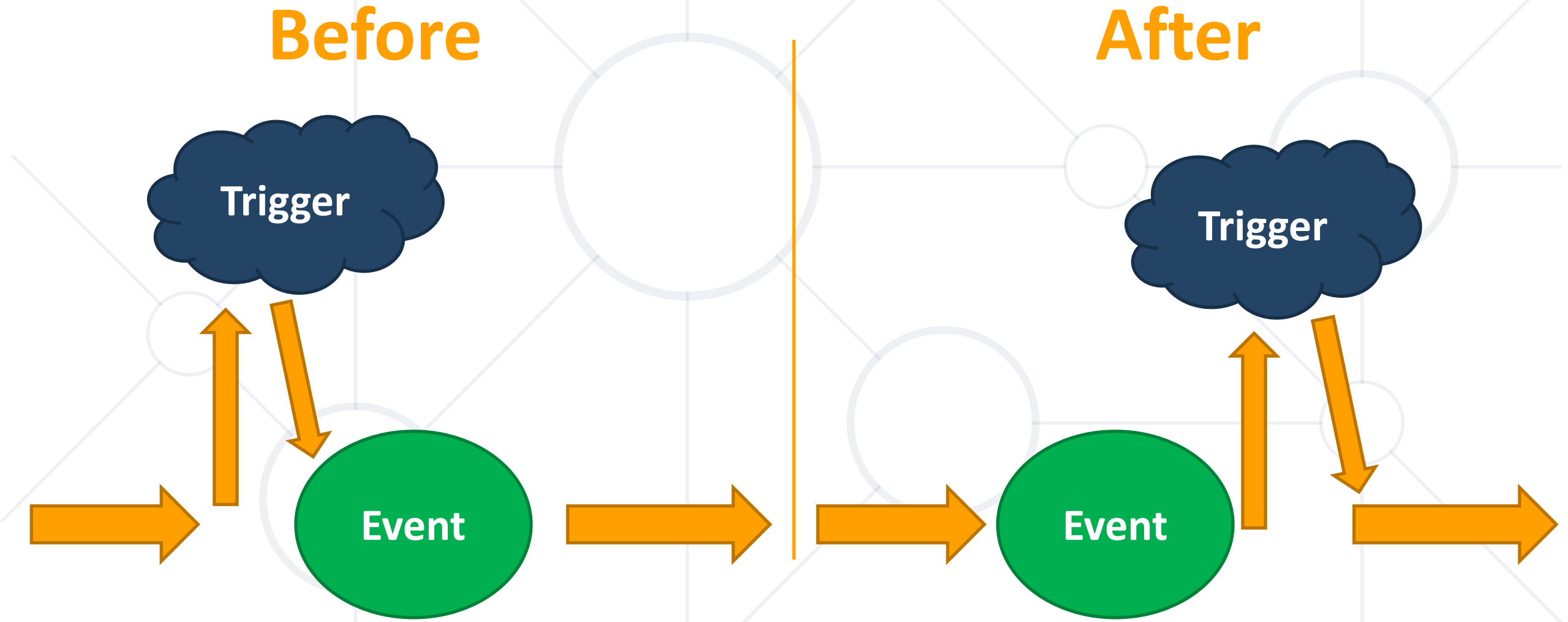
Triggers

Maintaining the Integrity of the Data

What Are Triggers?

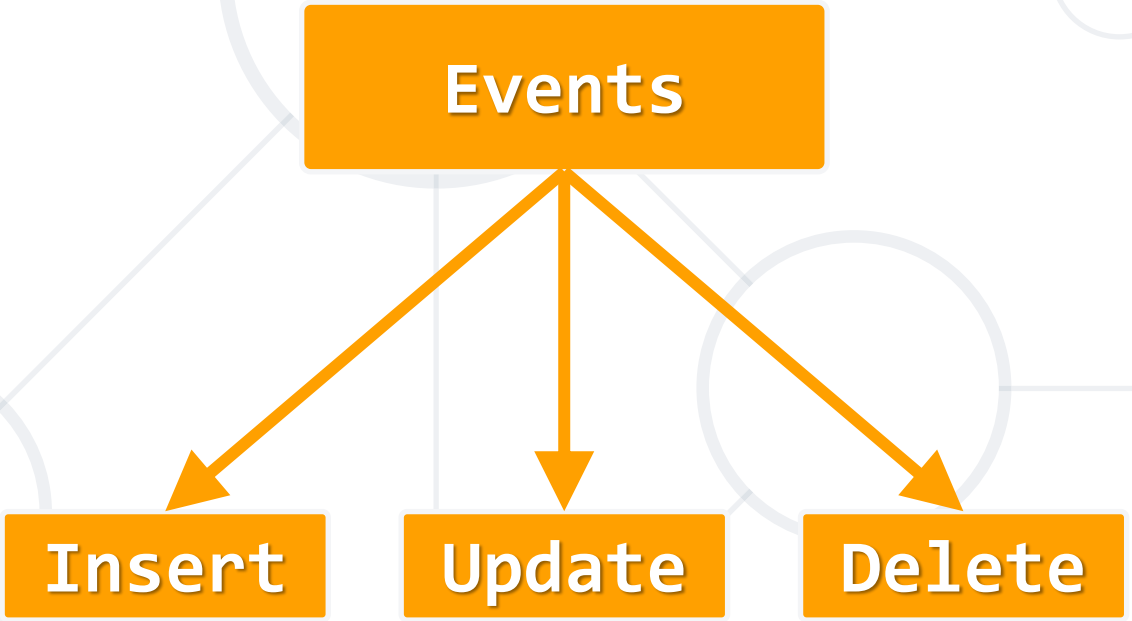
- Triggers - small programs in the database itself, activated by the database events application layer
  - UPDATE, DELETE or INSERT queries
  - Called in case of specific **event**
- We do not call triggers **explicitly**
  - Triggers are **attached** to a table

MySQL Types of Triggers



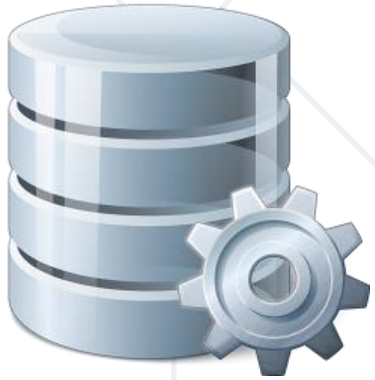
Events

- There are three different events that can be applied within a trigger:



Problem: Triggered

- Create a table deleted_employees with fields:
  - employee_id – primary key
  - first_name, last_name, middle_name, job_title, deparment_id, salary
- Add a trigger to the employees table that logs deleted employees into the deleted_employees table
  - Use soft_uni database



Solution: Triggered (1)

```
CREATE TABLE deleted_employees(
        employee_id INT PRIMARY KEY AUTO_INCREMENT,
        first_name VARCHAR(20),
        last_name VARCHAR(20),
        middle_name VARCHAR(20),
        job_title VARCHAR(50),
        department_id INT,
        salary DOUBLE
);
```

Solution: Triggered (2)

```
CREATE TRIGGER tr_deleted_employees
AFTER DELETE
ON employees
FOR EACH ROW
BEGIN
        INSERT INTO deleted_employees (first_name,last_name,
                    middle_name,job_title,department_id,salary)
        VALUES(OLD.first_name,OLD.last_name,OLD.middle_name,
                    OLD.job_title,OLD.department_id,OLD.salary);
END;
```

The OLD and NEW keywords allow you to access columns before/after trigger action

Result: Triggered

- Trigger action result on **DELETE**:
  - NOTE: Remove foreign key checks before trying to delete employees
  - **DO NOT** submit foreign key restriction changes in the Judge System

```
DELETE FROM employees WHERE employee_id IN (1);
```

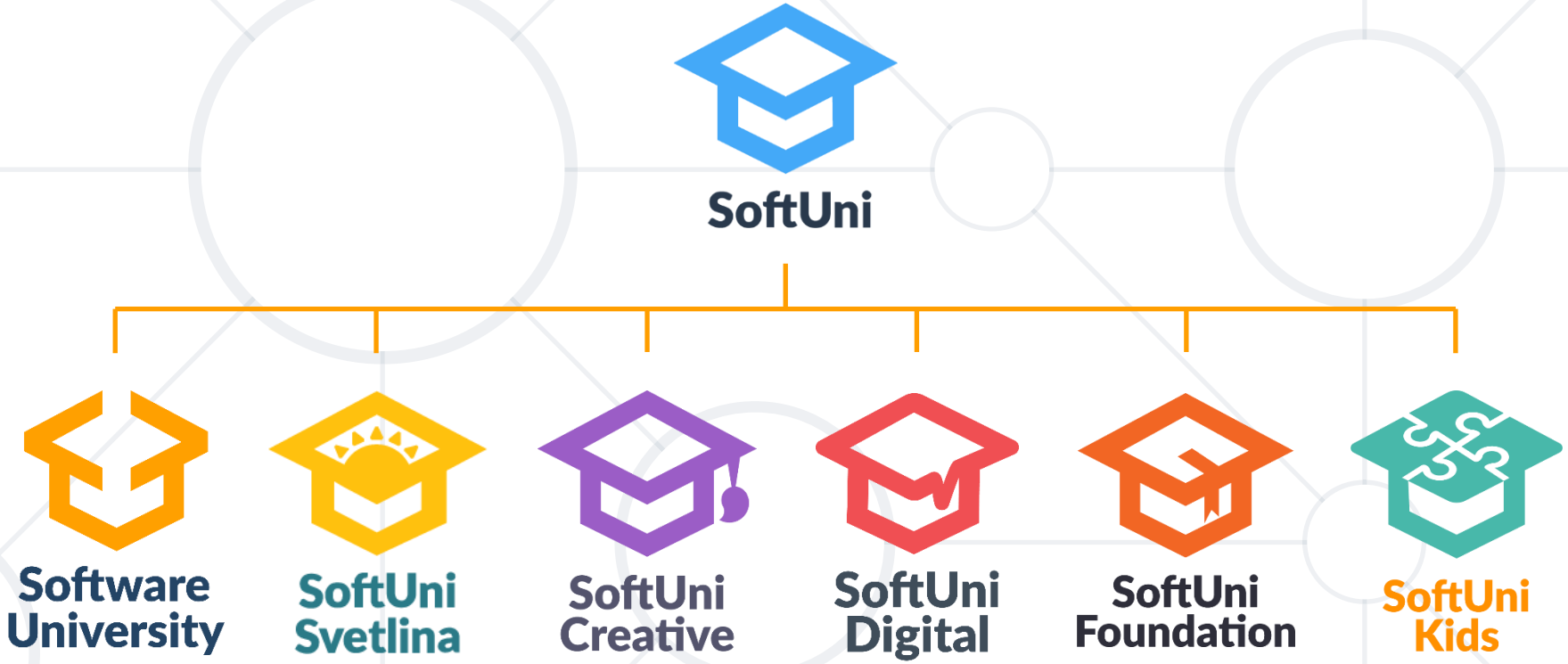
Data in deleted_employees table:

employee_id	first_name	last_name	…
1	Guy	Gilbert	…

Summary

- We can optimize with User-defined Functions.
- Transactions improve security and consistency.
- Stored Procedures encapsulate repetitive logic.
- Triggers execute before certain events on tables.

Questions?



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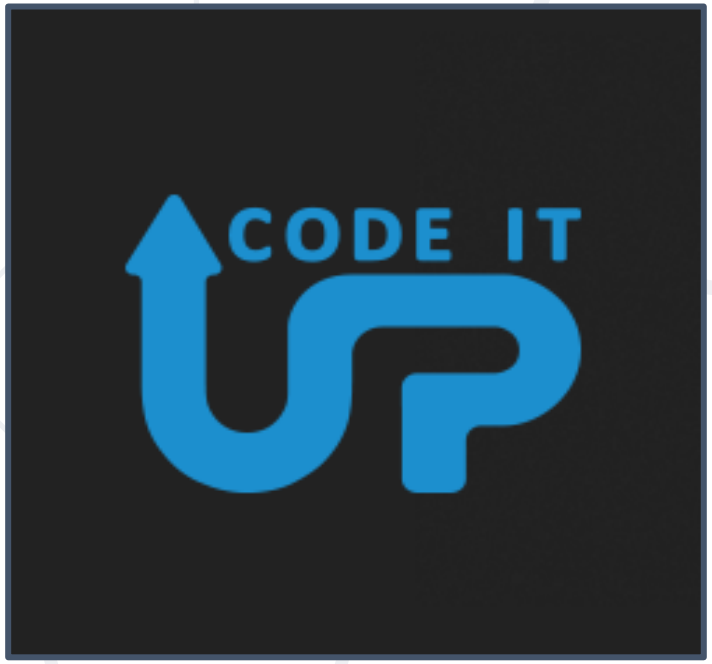

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