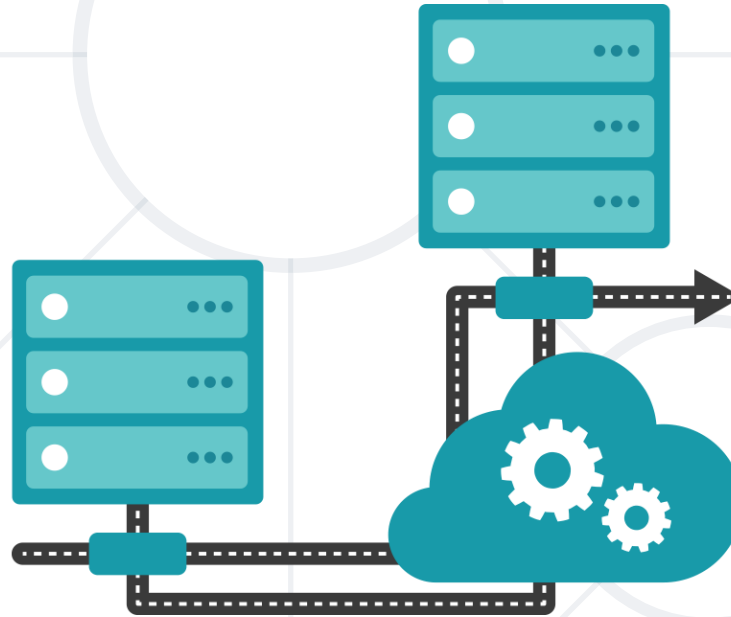


Database Programmability

User-defined Functions, Procedures, Triggers and Transactions



SoftUni Team
Technical Trainers



**Software
University**



**SoftUni
Foundation**



Software University

<http://softuni.bg>

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sli.do
#JavaDB



User-Defined Functions

Encapsulating custom logic

- 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 DOUBLE
```

```
BEGIN
```

```
    DECLARE e_count DOUBLE;
```

```
    SET e_count := (SELECT COUNT(employee_id) FROM employees AS e
```

```
    INNER JOIN addresses AS a ON a.address_id = e.address_id
```

```
    INNER 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

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



3

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



1

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



0

Employees
count



Stored Procedures

Sets of queries stored on DB Server

- 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 *

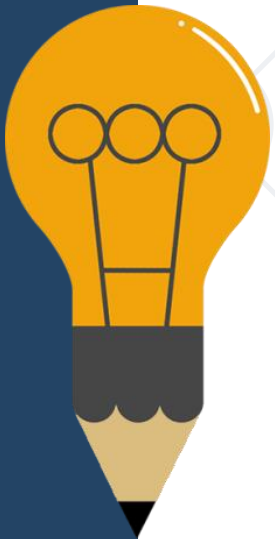
FROM employees

WHERE ROUND((DATEDIFF(NOW(), hire_date) / 365.25)) < 15;

END \$\$

Procedure Name

Procedure Logic



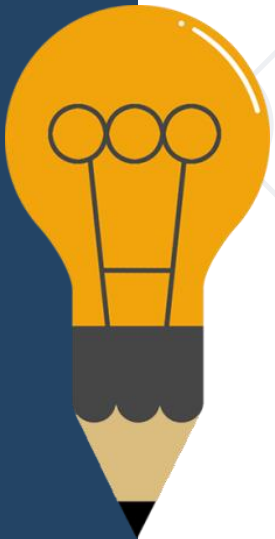
Executing and Dropping Stored Procedures

- Executing a stored procedure by **CALL**

```
CALL usp_select_employees_by_seniority();
```

- **DROP PROCEDURE**

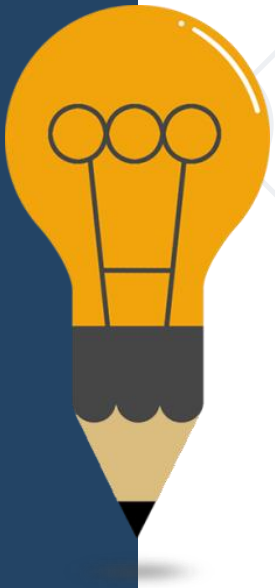
```
DROP PROCEDURE usp_select_employees_by_seniority;
```



Defining Parameterized Procedures

- 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

DELIMITER \$\$

Procedure Name

CREATE PROCEDURE usp_select_employees_by_seniority(min_years_at_work INT)

BEGIN

Procedure Logic

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 \$\$

Usage

CALL usp_select_employees_by_seniority(15);

Returning Values Using OUTPUT Parameters

```
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;
-- 11
```

Creating procedure

Executing procedure

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 var
char(50))
BEGIN
    UPDATE employees e
    INNER 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
...	...

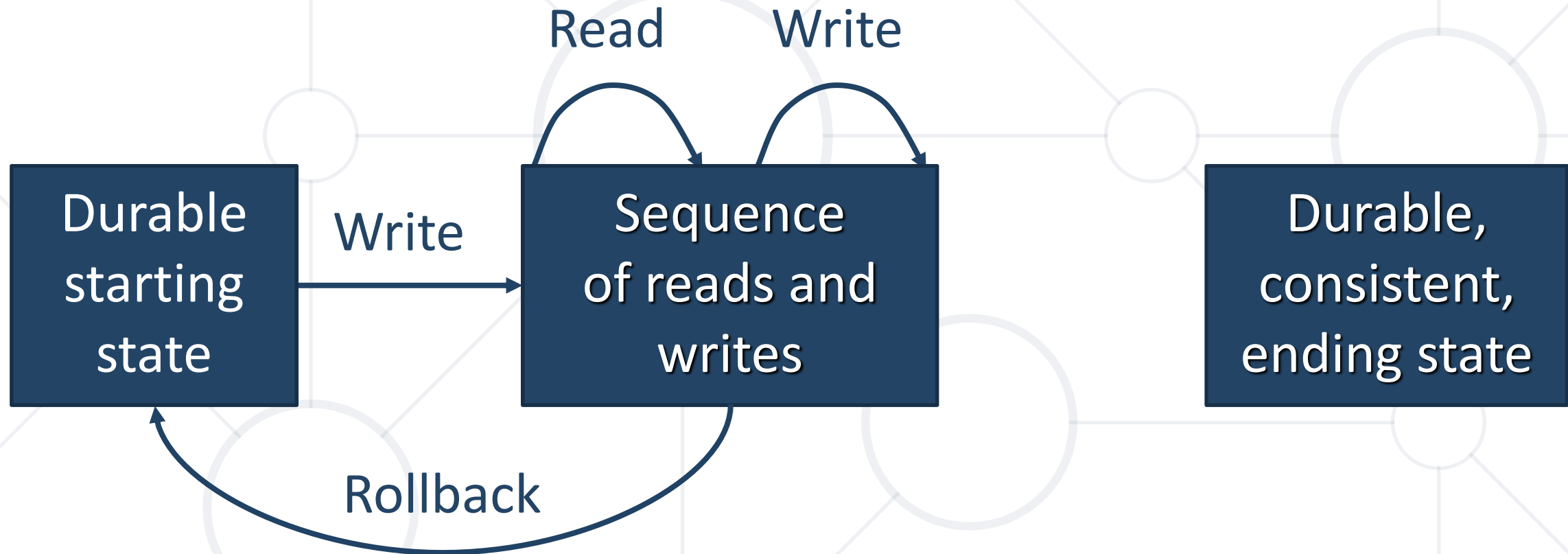


What is a Transaction?

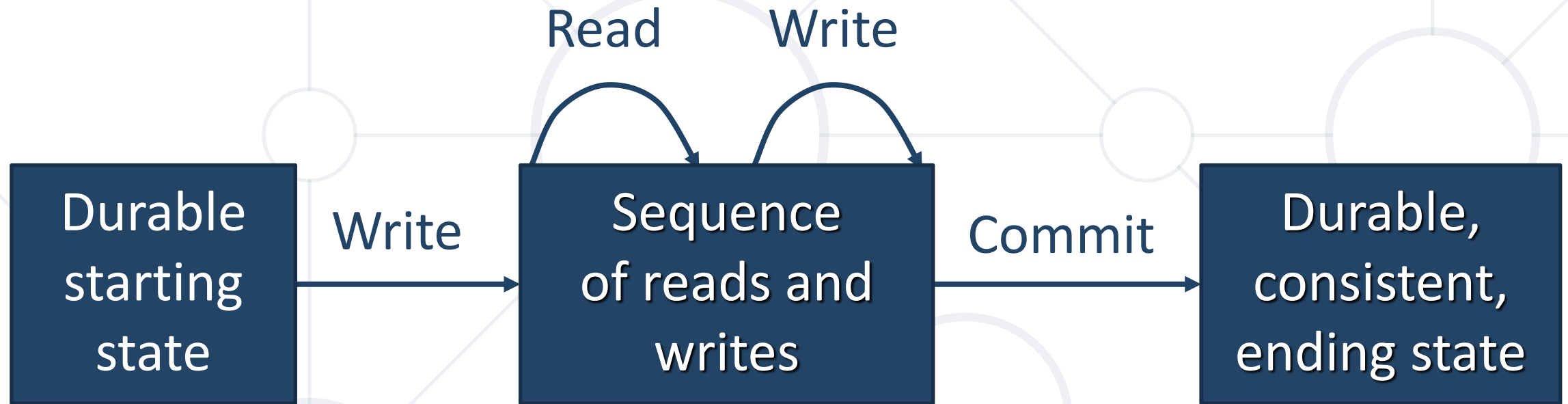
Executing operations as a whole

- 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)

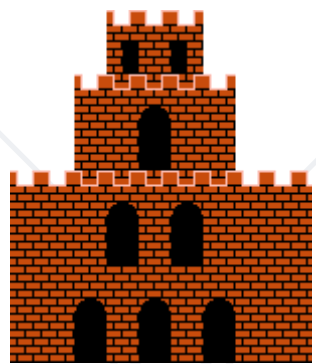


Transactions Behavior

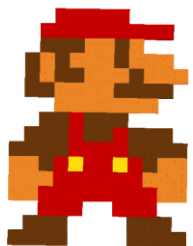
- Transactions guarantee the **consistency** and the **integrity** of the database.
 - All changes in a transaction are temporary
 - Changes are persisted when **COMMIT** is executed
 - At any time all changes can be canceled by **ROLLBACK**
- All of the operations are executed as a whole.



Checkpoints in games



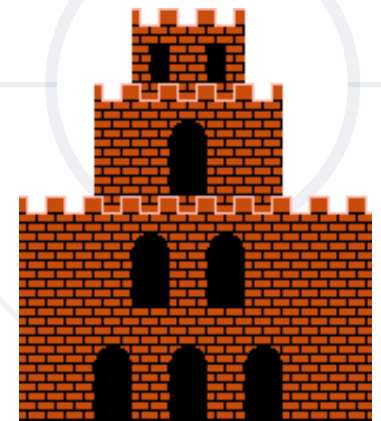
Castle 1-1



Mario

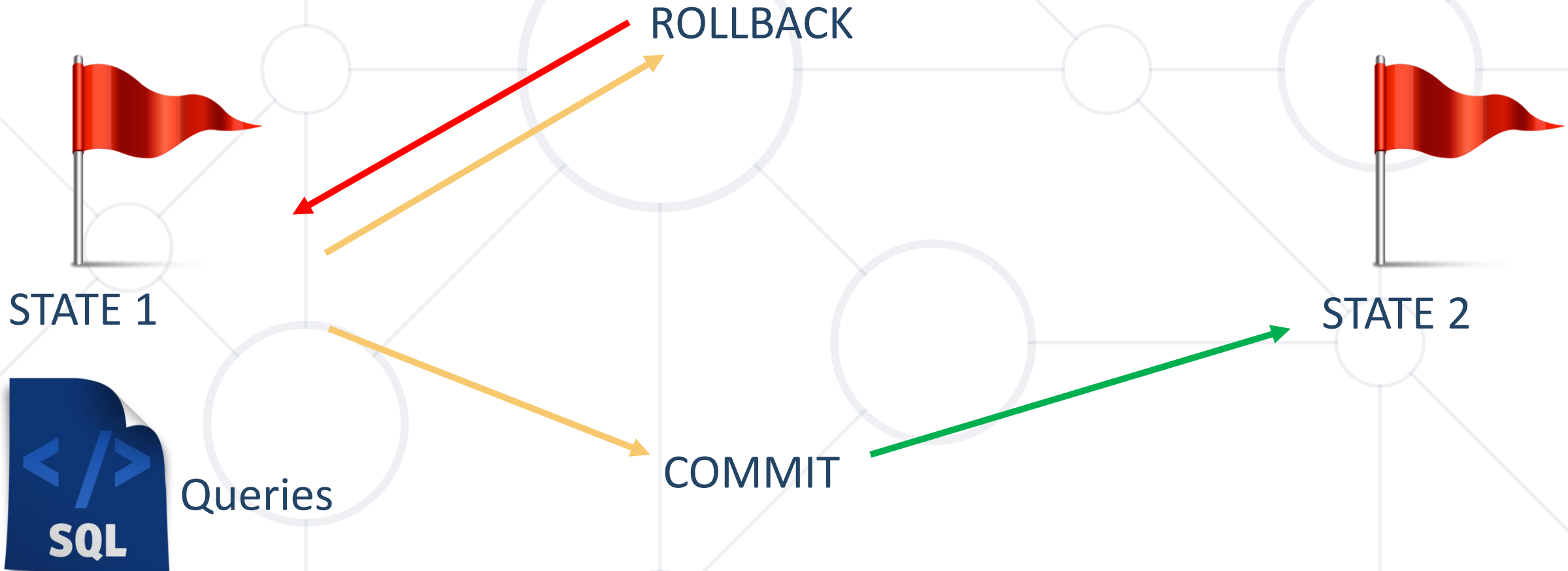
DIE

SURVIVE



Castle 1-2

What are Transactions?



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
```

- 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

Before

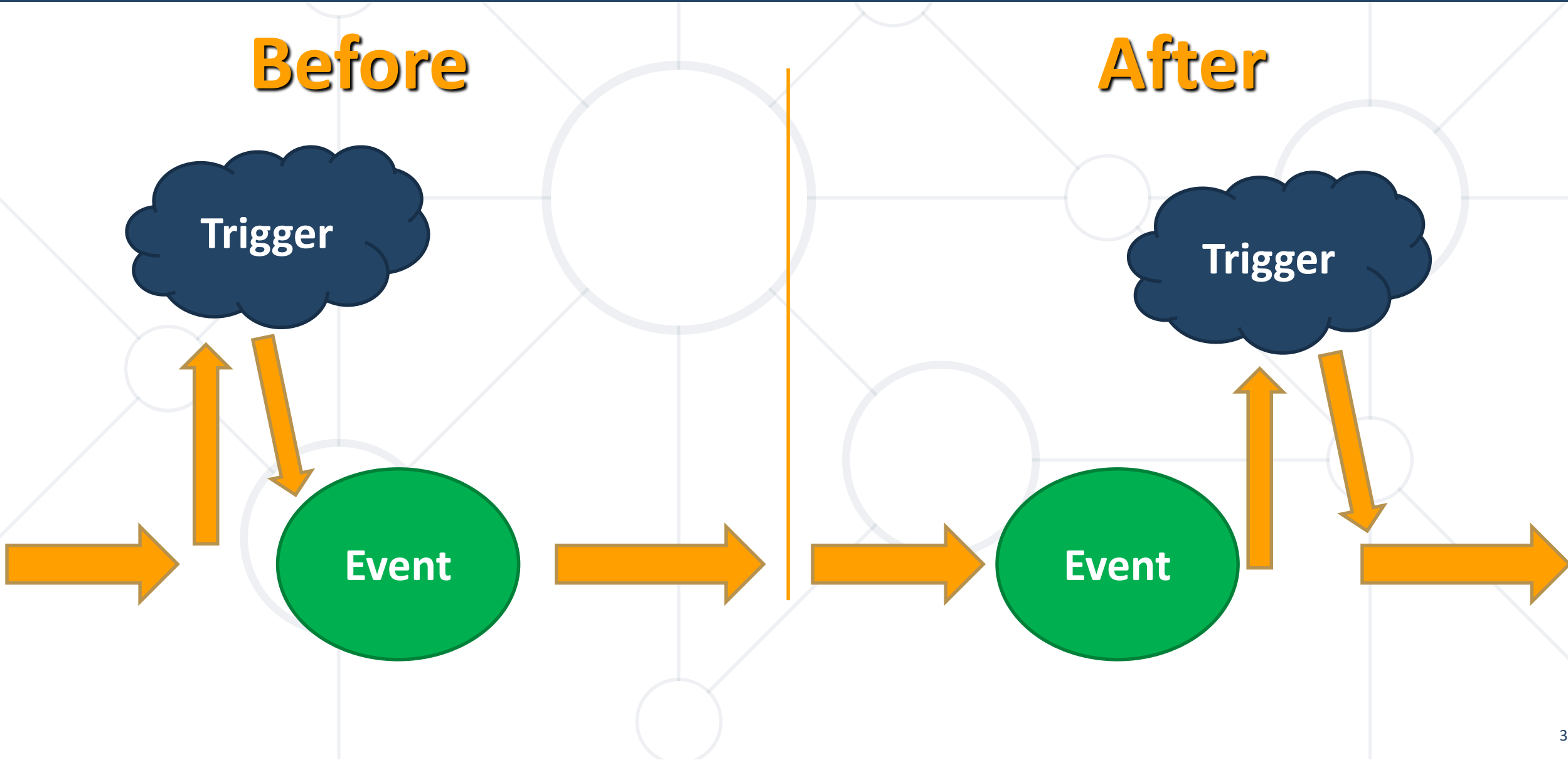
Trigger

Event

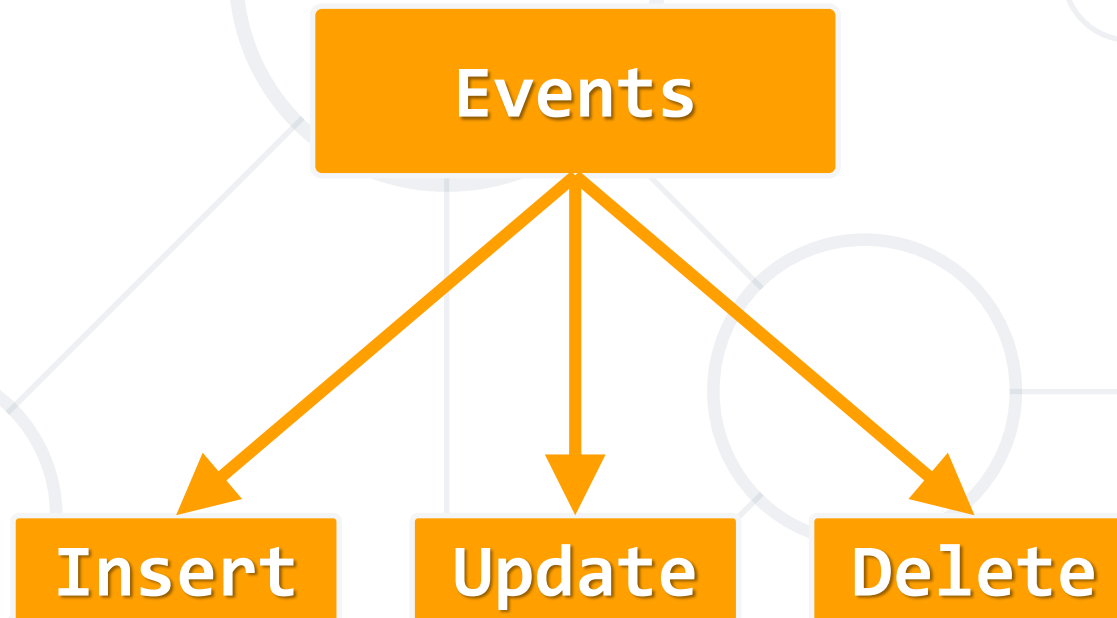
After

Trigger

Event

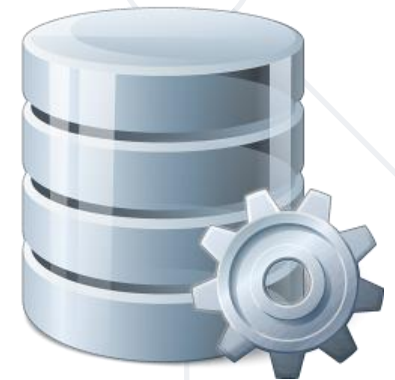


- There are three different events that can be applied within a trigger:



Problem: Triggered

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



```
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

- 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);
```

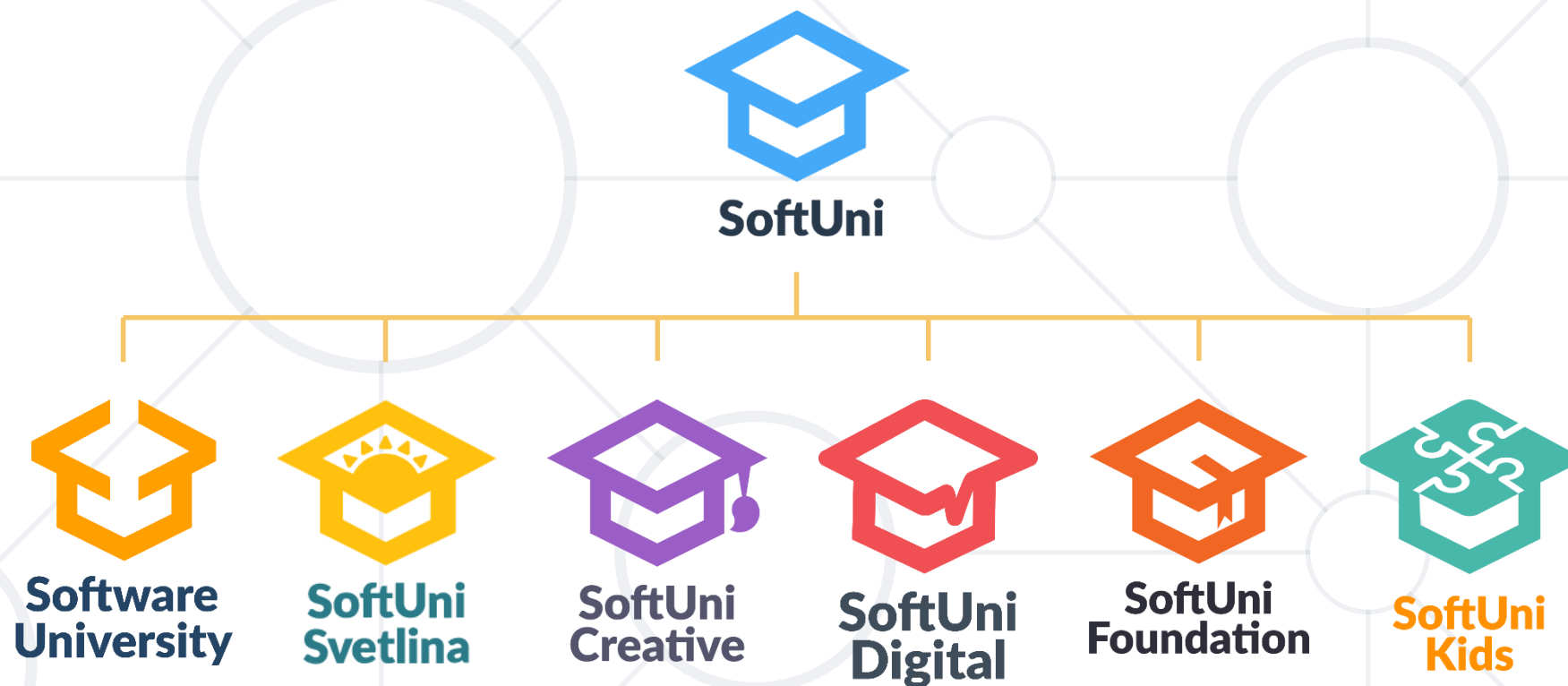
Data in deleted_employees table:

employee_id	first_name	last_name	...
1	Guy	Gilbert	...

- 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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