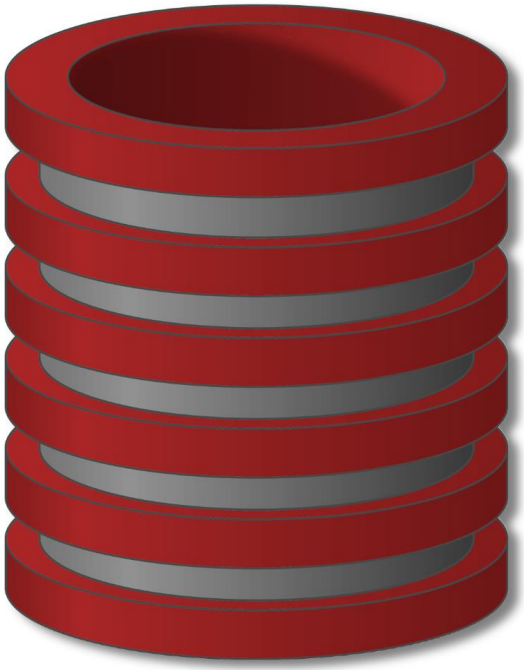

Constraints & Triggers

Triggers – Introduction

Triggers

"Event-Condition-Action Rules"

When *event* occurs, check *condition*; if true, do *action*

1) Move monitoring logic from apps into DBMS

2) Enforce constraints
   - Beyond what constraint system supports
   - Automatic constraint "repair"

✳ Implementations vary significantly

This intro: SQL standard

Demo: SQLite

Triggers in SQL

```
Create Trigger name
Before|After|Instead Of events
[ referencing-variables ]
[ For Each Row ]
When ( condition )
action
```

Referential Integrity:
R.A references S.B, cascaded delete

```
Create Trigger Cascade
After Delete On S
Referencing Old Row As O
For Each Row
[ no condition ]
Delete From R Where A = O.B
```

Referential Integrity:
R.A references S.B, cascaded delete

```
Create Trigger Cascade
After Delete On S
Referencing Old Row As O
[ For Each Row ]
[ no condition ]
Delete From R Where A = O.B
```

Referential Integrity:
R.A references S.B, cascaded delete

```
Create Trigger Cascade
After Delete On S
Referencing Old Table As OT
[ For Each Row ]
[ no condition ]
Delete From R Where A = O.B
```

Referential Integrity:
R.A references S.B, cascaded delete

```
Create Trigger Cascade
After Delete On S
Referencing Old Table As OT
[ For Each Row ]
[ no condition ]
Delete From R Where A in (select B from OT)
```

Tricky Issues

- Row-level vs. Statement-level
  - `New/Old Row` and `New/Old Table`
  - `Before, Instead Of`
- Multiple triggers activated at same time
- Trigger actions activating other triggers (chaining)
  - Also self-triggering, cycles, nested invocations
- Conditions in **`When`** vs. as part of action

✳ Implementations vary significantly

T(K,V) – K key, V value

```
Create Trigger IncreaseInserts
After Insert On T
Referencing New Row As NR, New Table As NT
For Each Row
When (Select Avg(V) From T) <
     (Select Avg(V) From NT)
Update T set V=V+10 where K=NR.K
```

- No statement-level equivalent
- Nondeterministic final state

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✳ Implementations vary significantly