

《数据库原理与设计》实验报告

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|--|--------------|---------------|---|----|--|
| 年级、专业、班级 | | 2024 级软件工程 01 | | 姓名 | |
| 实验题目 | 实验 6 数据完整性控制 | | | | |
| 实验时间 | 2024/10/22 | 实验地点 | DS1501 | | |
| 实验成绩 | | 实验性质 | <input checked="" type="checkbox"/> 验证性 <input type="checkbox"/> 设计性 <input type="checkbox"/> 综合性 | | |
| <p>教师评价：</p> <p><input type="checkbox"/>算法/实验过程正确； <input type="checkbox"/>源程序/实验内容提交 <input type="checkbox"/>程序结构/实验步骤合理；</p> <p><input type="checkbox"/>实验结果正确； <input type="checkbox"/>语法、语义正确； <input type="checkbox"/>报告规范；</p> <p>其他：</p> <p>评价教师签名：</p> | | | | | |
| <p>一、实验目的</p> <p>[1] 掌握实体完整性的创建和修改方法；</p> <p>[2] 掌握参照完整性的创建和修改方法；</p> <p>[3] 掌握用户定义的完整性的创建和修改方法；</p> <p>[4] 掌握触发器的创建和修改。</p> | | | | | |
| <p>二、实验项目内容</p> <p>针对数据库 Library 进行下面的实验：</p> <ol style="list-style-type: none">对各个表实现实体完整性并验证；实现表之间的参照完整性并验证；实现下列约束并验证：<ol style="list-style-type: none">姓名不能为空值。性别应该为“男”或“女”。年龄必须在 0 到 100 之间。价格必须大于 0。借阅日期默认为当前日期。创建触发器，当删除 Reader 表中读者的信息时，同时删除 Borrow 表中该读者的记录。创建一个表 Book_Count，用来记录每本书被借阅的次数，关系模式为 (Bno, BorrowTimes)，其中 Bno 表示图书编号，BorrowTimes 表示借阅次数。现要求在 Borrow 表上创建一个触发器，当有新的借阅记录时，更新 Book_Count 表的信息，将被借图书的借阅次数加 1。 | | | | | |

报告创建时间：

三、实验过程或算法（源程序）

1.

```
alter table test1 add primary key (bno);
```

验证: insert into test1 values('B07','计算机','王小明','88.8'); ×

```
insert into test1 values('B08','计算机','王小明','88.8'); ✓
```

```
alter table book add unique (bno);
```

验证: insert into book values('B11','计算机','王小明','88.8'); ×

```
insert into book values('B02','计算机','王小明','88.8'); ✓
```

2.

```
alter table library.borrow
```

```
add constraint bno foreign key (bno)
```

```
references library.book(bno)
```

```
on delete no action
```

```
on update no action;
```

验证: insert into borrow(borrnum, bno) values('10','b11'); ✓

```
insert into borrow(borrnum, bno) values('11','b12'); ×
```

3.

```
alter table reader
```

```
add constraint sex_check check(rsex='男' or rsex='女') enforced;
```

```
alter table reader
```

```
add constraint age_check check(rage>=0 and rage<=100) enforced;
```

```
alter table book
```

```
add constraint price_check check(bprice>0) enforced;
```

```
ALTER TABLE borrow MODIFY borrowdate TIMESTAMP DEFAULT CURRENT_TIMESTAMP;
```

验证:

```
insert into reader(rno,rname,rsex,rage) values ('r07',null,'沃尔玛塑料袋','107');
```

×

```
insert into reader(rno,rname,rsex,rage) values ('r07','余里','沃尔玛塑料袋','107'); ×
```

```
insert into reader(rno,rname,rsex,rage) values ('r07','余里','男','107'); ×
```

```
insert into reader(rno,rname,rsex,rage) values ('r07','余里','男','17'); ✓
```

```
insert into book(bno,bprice) values ('b12','11'); ✓
```

```
insert into book(bno,bprice) values ('b13','-11'); ×
```

```
insert into borrow(borrnum,bno) values ('10','B06')
```

4.

```
delete from reader where rno='R01';
```

5.

```
create table book_count(
```

```
bno char(10),borrowtimes int(4)
);
```

```
Insert                into                book_count(bno,borrowtimes)
values('b01','0'),('b02','0'),('b03','0'),('b04','0'),('b05','0'),('b06','0'),('b11','0'),('b12'
,'0')
insert into borrow(borrnum,bno) values('13','b02')
```

四、实验结果及分析和（或）源程序调试过程

1. 设置主键

| Column Name | Datatype | PK | NN | UQ | B | UN | ZF | AI | G | Default/Expression |
|-------------|----------|-------------------------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------|
| borrnum | INT | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| bno | CHAR(10) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | NULL |
| bno | CHAR(10) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | NULL |

Column Name: borrnum

Charset/Collation: Default Charset Default Collation

Comments:

Data Type: INT

Default:

Storage: ☐ Virtual ☐ Stored

☒ Primary Key ☒ Not Null ☐ Unique

☐ Binary ☐ Unsigned ☐ Zero Fill

☐ Auto Increment ☐ Generated

```
• alter table test1 add primary key (bno);
```

当插入主键相同是元组时将被拒绝

```
1 • SELECT * FROM library.test1;
```

| Result Grid | | | |
|--------------|-----|---------|----------------|
| Filter Rows: | | | |
| | bno | bttitle | bauthor bprice |
| ▶ | B02 | 计算机网络基础 | 孙河 40.00 |
| | B03 | 操作系统概论 | 林东 52.00 |
| | B04 | c++程序设计 | 刘伟 43.00 |
| | B05 | 数据库基础 | 陈宏伟 39.00 |
| | B06 | 英语世界 | 王大海 24.00 |

```
1 insert into test1 values('B02','计算机','王小明','88.8');
2
```

| Output | | | |
|---------------|----------|--|---|
| Action Output | | | |
| # | Time | Action | Message |
| ✖ 1 | 19:22:07 | insert into test1 values('B02','计算机','王小明','88.8') | Error Code: 1062. Duplicate entry 'B02' for key 'test1.PRIMARY' |

但是主键不一致则可以插入

```
1 insert into test1 values('B08','计算机','王小明','88.8');
2
```

| Output | | | |
|---------------|----------|--|-------------------|
| Action Output | | | |
| # | Time | Action | Message |
| ✔ 1 | 19:23:56 | insert into test1 values('B08','计算机','王小明','88.8') | 1 row(s) affected |

或者设置 unique 约束:

Table Name: book Schema: library

| Column Name | Datatype | PK | NN | UQ | B | UN | ZF | AI | G | Default/Expression |
|-------------|--------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------|
| ✱ bno | CHAR(10) | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| ◇ bttitle | VARCHAR(100) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | NULL |
| ◇ bauthor | VARCHAR(50) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | NULL |
| ◇ bprice | DECIMAL(5,2) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | NULL |

Column Name: bno

Charset/Collation: Default Charset Default Collation

Comments:

Data Type: CHAR(10)

Default:

Storage: ☒ Primary Key ☒ Not Null ☒ Unique ☐ Binary ☐ Unsigned ☐ Zero Fill ☐ Auto Increment ☐ Generated

Columns Indexes Foreign Keys Triggers Partitioning Options

```
1 • alter table book add unique (bno);
2
```

Output

Action Output

| # | Time | Action | Message |
|-----|----------|-----------------------------------|--|
| ✔ 1 | 19:29:47 | alter table book add unique (bno) | 0 row(s) affected Records: 0 Duplicates: 0 Warnings: 0 |

当插入值与 unique 列已有数据一样时不能成功，反之可以成功

1 • insert into book values('B11','计算机','王小明','88.8');

2 • insert into book values('B02','计算机','王小明','88.8');

3

Output

Action Output

| # | Time | Action | Message |
|-----|----------|---|--|
| ✓ 1 | 19:34:29 | insert into book values('B11','计算机','王小明','88.8') | 1 row(s) affected |
| ✗ 2 | 19:34:29 | insert into book values('B02','计算机','王小明','88.8') | Error Code: 1062. Duplicate entry 'B02' for key 'book.PRIMARY' |

2.（参照完整性）

现在为 borrow 表中的 bno 设置外键，参照 book 表中的 bno

Table Name: borrow

Schema: library

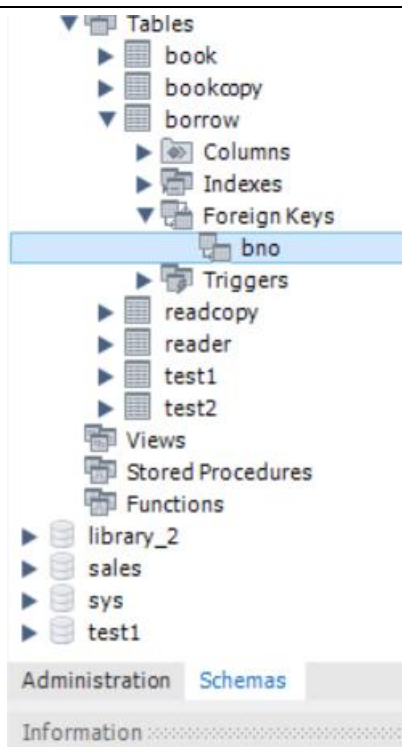
Charset/Collation: utf8mb4 utf8mb4_0900_ai_ci

Engine: InnoDB

Comments:

| Foreign Key Name | Referenced Table |
|------------------|------------------|
| bno | "library"."book" |

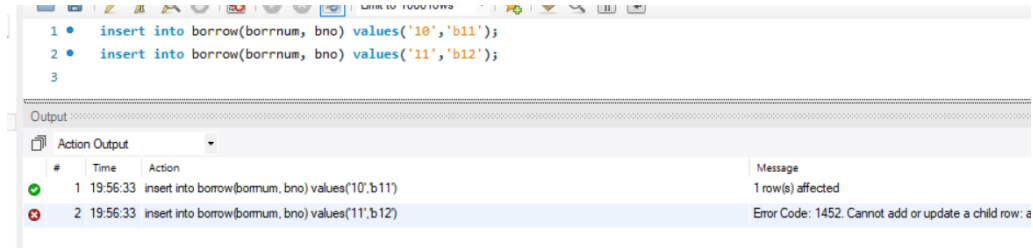
| Column | Referenced Column |
|---|-------------------|
| <input type="checkbox"/> borrownum | |
| <input type="checkbox"/> rno | |
| <input checked="" type="checkbox"/> bno | bno |
| <input type="checkbox"/> borrowdate | |
| <input type="checkbox"/> returndate | |



也可以使用 SQL 语句

```
alter table library.borrow add constraint bno foreign key (bno) references library.book(bno) on delete no action on update no action;
```

验证参照完整性



3.

| rno | CHAR(10) | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
|-------|-------------|-------------------------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| rname | VARCHAR(20) | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| rsex | VARCHAR(2) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | NULL |

Column Name: rname

Charset/Collation: Default Charset Default Collation

Comments:

Data Type: VARCHAR(20)

Default:

Storage: ☐ Virtual ☐ Stored

☐ Primary Key
☒ Not Null
☐ Unsigned
☐ Zero

☐ Binary
☐ Unsigned
☐ Zero

☐ Auto Increment
☐ Generated

```

1 • alter table reader
2   add constraint sex_check check(rsex='男' or rsex='女') enforced;
3 • alter table reader
4   add constraint age_check check(rage>=0 and rage<=100) enforced;
5 • alter table book
6   add constraint price_check check(bprice>0) enforced;
7

```

| # | Time | Action | Message |
|---|----------|---|---|
| 1 | 19:56:33 | insert into borrow(borrownum, bno) values('10','b11') | 1 row(s) affected |
| 2 | 19:56:33 | insert into borrow(borrownum, bno) values('11','b12') | Error Code: 1452. Cannot add or update a child row: a foreign key |
| 3 | 20:01:10 | Apply changes to reader | Changes applied |
| 4 | 20:09:31 | alter table reader add constraint sex_check check(rsex='男' or rsex='女') enforced | 6 row(s) affected Records: 6 Duplicates: 0 Warnings: 0 |
| 5 | 20:09:31 | alter table reader add constraint age_check check(rage>=0 and rage<=100) enforced | 6 row(s) affected Records: 6 Duplicates: 0 Warnings: 0 |
| 6 | 20:09:31 | alter table book add constraint price_check check(bprice>0) enforced | 7 row(s) affected Records: 7 Duplicates: 0 Warnings: 0 |

• **ALTER TABLE borrow**
MODIFY borrowdate TIMESTAMP DEFAULT CURRENT_TIMESTAMP;

验证：
关于 reader 表

```

1 • insert into reader(rno,rname,rsex,rage) values ('r07',null,'沃尔玛塑料袋','107');
2 • insert into reader(rno,rname,rsex,rage) values ('r07','余里','沃尔玛塑料袋','107');
3 • insert into reader(rno,rname,rsex,rage) values ('r07','余里','男','107');
4 • insert into reader(rno,rname,rsex,rage) values ('r07','余里','男','17');
5

```

| | | | |
|---|----------|--|---|
| 2 | 20:15:50 | insert into reader(rno,rname,rsex,rage) values ('r07',null,'沃尔玛塑料袋','107') | Error Code: 1048. Column 'rname' cannot be null |
| 3 | 20:16:02 | insert into reader(rno,rname,rsex,rage) values ('r07','余里','沃尔玛塑料袋','107') | Error Code: 1406. Data too long for column 'rsex' at row 1 |
| 4 | 20:17:17 | insert into reader(rno,rname,rsex,rage) values ('r07','余里','男','107') | Error Code: 3819. Check constraint 'age_check' is violated. |
| 5 | 20:17:21 | insert into reader(rno,rname,rsex,rage) values ('r07','余里','男','17') | 1 row(s) affected |

关于 book 表（新插入行默认实验时的时间为借阅时间）

| # | Time | Action | Message |
|---|----------|---|---|
| 1 | 20:20:24 | insert into book(bno,bprice) values ('b12','11'); | 1 row(s) affected |
| 2 | 20:20:24 | insert into book(bno,bprice) values ('b13','11'); | Error Code: 3819. Check constraint 'price_check' is violated. |

5.图形界面:

Comments:

BEFORE INSERT
▼ AFTER INSERT
 borrow_AFTER_INSERT
BEFORE UPDATE
AFTER UPDATE
BEFORE DELETE
AFTER DELETE

```
1 • CREATE DEFINER='root'@'localhost' TRIGGER `borrow_AFTER_INSERT` AFTER INSERT ON `borrow` FOR EACH ROW BEGIN
2   update book_count b set borrowtimes=borrowtimes+1 where new.bno=b.bno;
3   END
```

Algorithm: Lock Type:

Sql 语句:

```
1 DROP TRIGGER IF EXISTS `library`.`borrow_AFTER_INSERT`;
2
3 DELIMITER $$
4 USE `library` $$
5 CREATE DEFINER = CURRENT_USER TRIGGER `library`.`borrow_AFTER_INSERT` A
6 BEGIN
7   update book_count b set borrowtimes=borrowtimes+1 where new.bno=b.bno;
8 END$$
9 DELIMITER ;
10
```

验证:

新添加一条 borrow 记录, b02 的次数加一

Limit to 1000 rows

```
• insert into borrow(borrnum,bno) values('13','b02')
```

| | bno | borrowtimes |
|--|-----|-------------|
| | b01 | 0 |
| | b02 | 1 |
| | b03 | 0 |
| | b04 | 0 |
| | b05 | 0 |
| | b06 | 0 |
| | b11 | 0 |
| | b12 | 0 |

book_count 3 ×