《数据库系统及应用实践》课程实验报告

实验 1：在 Docker 环境下使用 MySQL

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1 实验目标

1. 学习 Docker 环境的原理和基本操作
2. 能够通过 Docker 容器启动 MySQL 数据库实例
3. 掌握连接和操作 MySQL 数据库的基本命令

2 实验过程记录

2.1 安装 Docker

我的实验环境是 Ubuntu 22.04 LTS on Windows 10 x86_64，在这里，我选择按照官网文档（https://docs.docker.com/engine/install/ubuntu/）安装 Docker。

首先，添加 Docker 的 apt 源：

```
# Add Docker's official GPG key:
sudo apt-get update
sudo apt-get install ca-certificates curl
sudo install -m 0755 -d /etc/apt/keyrings
sudo curl -fsSL https://download.docker.com/linux/ubuntu/gpg -o /etc/apt/keyrings/docker.asc
sudo chmod a+r /etc/apt/keyrings/docker.asc

# Add the repository to Apt sources:
echo \
  "deb [arch=$(dpkg --print-architecture) signed-by=/etc/apt/keyrings/docker.asc] https://download.docker.com/linux/ubuntu \
  $(. /etc/os-release && echo "$VERSION_CODENAME") stable" | \
  sudo tee /etc/apt/sources.list.d/docker.list > /dev/null
sudo apt-get update
```

然后使用 apt 安装 Docker：

```
sudo apt-get install docker-ce docker-ce-cli containerd.io docker-buildx-plugin docker-compose-plugin
```

待安装完成后，运行命令以检查 Docker 是否安装成功：

```
sudo docker run hello-world
```

输出结果如下图所示，说明 Docker 安装成功。

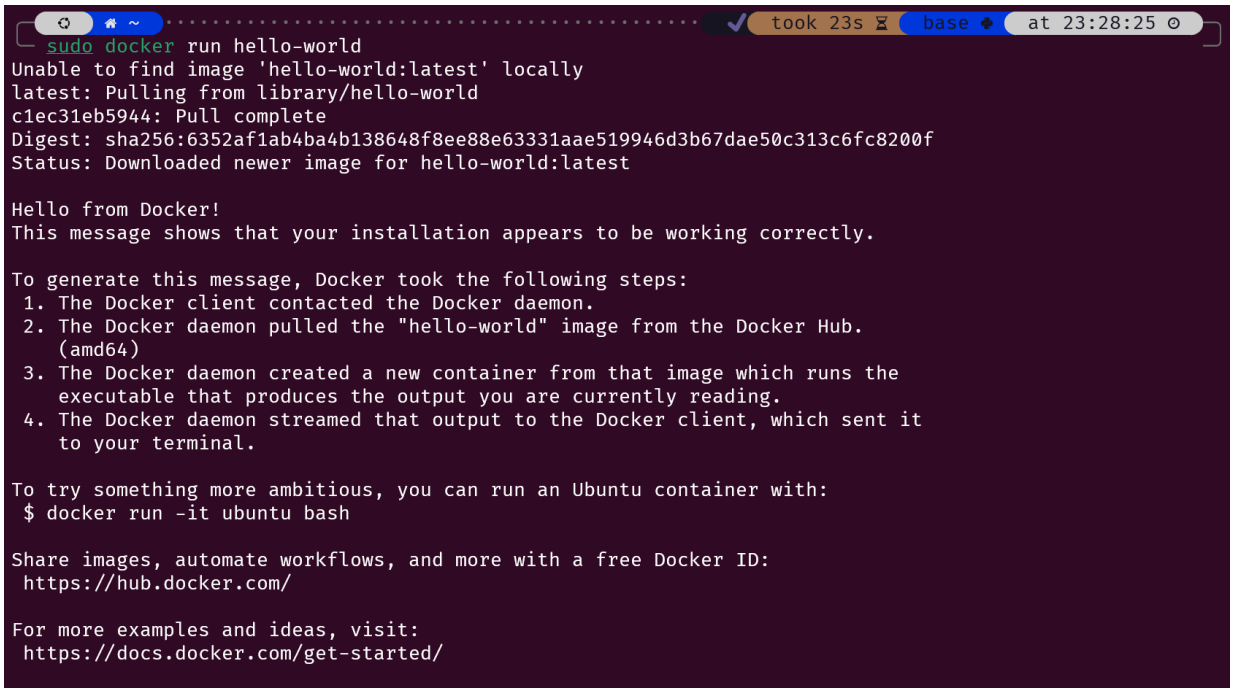


图 1: 检查 Docker 是否安装成功

2.2 在容器中启动 MySQL 示例

首先，创建一个 dbcourse 文件夹，并在其中创建一个 datadir 文件夹：

```
mkdir dbcourse
cd dbcourse
mkdir datadir
```

然后拉取 MySQL 镜像：

```
sudo docker pull mysql:8.2.0
```

结果如下图所示：

```
~ ····· base at 00:06:51
sudo docker pull mysql:8.2.0
8.2.0: Pulling from library/mysql
558b7d69a2e5: Pull complete
599b67b0dd6a: Pull complete
50314d46ce2b: Pull complete
494babc92263: Pull complete
02548e6f2dbf: Pull complete
a9e5e2637e0d: Pull complete
657b198fe6b7: Pull complete
215a2b0eabbf: Pull complete
377a4c7a89c5: Pull complete
4bfe599fe218: Pull complete
Digest: sha256:212fe73edca5df6ff14826d5eb975c914bfb91f82a2e923f9050568f99525da1
Status: Downloaded newer image for mysql:8.2.0
docker.io/library/mysql:8.2.0
```

图 2: 拉取 MySQL 镜像

接下来，使用如下命令启动一个 MySQL 容器：

```
sudo docker run --name dbcourse -v ./datadir:/var/lib/mysql -e MYSQL_ROOT_PASSWORD=
    password -d -p 53306:3306 mysql:8.2.0
```

这个命令将会创建一个名为 dbcourse 的容器，并将容器内的 /var/lib/mysql 文件夹映射到宿主机的 ./datadir 文件夹，设置 root 用户的密码为 password，将容器的 3306 端口映射到宿主机的 53306 端口。

结果如下图所示：

```
~/dbcourse ····· base at 00:15:51
sudo docker run --name dbcourse -v ./datadir:/var/lib/mysql -e MYSQL_ROOT_PASSWORD=password -d -p 5330
6:3306 mysql:8.2.0
1da884ed16dcf7066eb9c7a93f7829ea4360f6fd9bce6ddb99275ecb70458cb8
```

图 3: 创建容器

使用 docker ps 命令可以看到这个容器正在运行：

```
~/dbcourse ····· base at 00:18:50
sudo docker ps
CONTAINER ID   IMAGE          COMMAND                  CREATED          STATUS          PORTS
                                                    NAMES
1da884ed16dc   mysql:8.2.0    "docker-entrypoint.s…"   2 minutes ago    Up 2 minutes    33060/
tcp, 0.0.0.0:53306→3306/tcp, :::53306→3306/tcp   dbcourse
```

图 4: 查看运行中的容器

2.3 对 MySQL 数据库进行操作

执行如下命令，启动容器内的一个 bash 终端：

```
sudo docker exec -it dbcourse bash
```

结果如下：

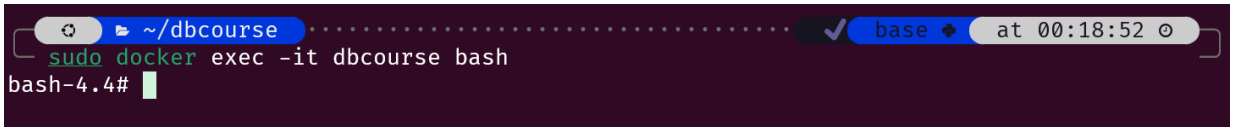


图 5: 启动容器内的 bash 终端

使用命令登录 MySQL 数据库：

```
mysql --user=root --password=password
```

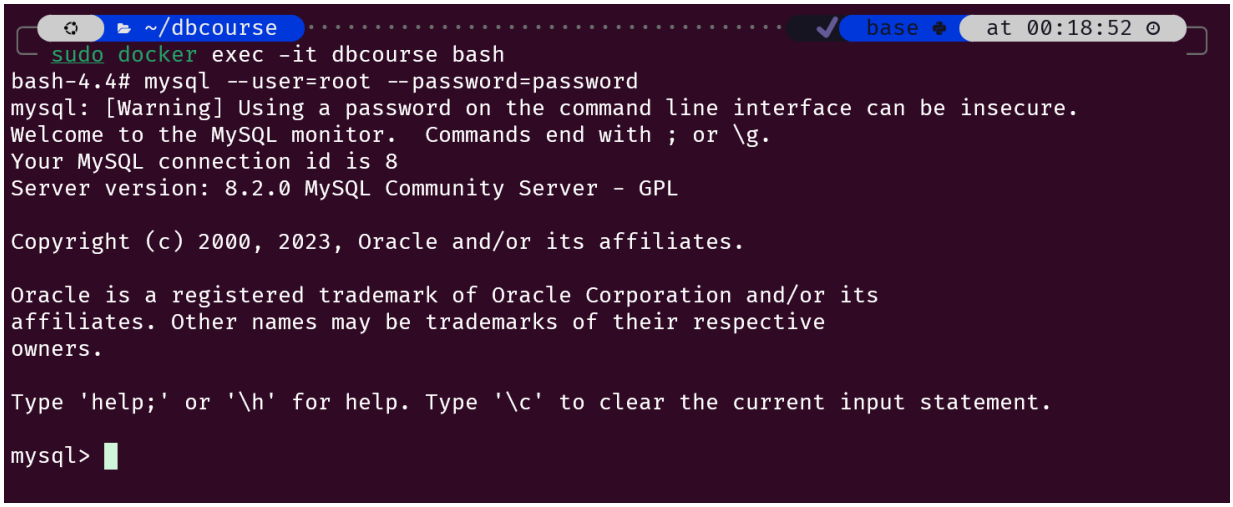


图 6: 登录 MySQL

执行 help 命令，可以看到 MySQL 的帮助信息：

```
help;
```

```
edit      (\e) Edit command with $EDITOR.
ego       (\G) Send command to mysql server, display result vertically.
exit      (\q) Exit mysql. Same as quit.
go        (\g) Send command to mysql server.
help      (\h) Display this help.
nopager   (\n) Disable pager, print to stdout.
notee     (\t) Don't write into outfile.
pager     (\P) Set PAGER [to_pager]. Print the query results via PAGER.
print     (\p) Print current command.
prompt    (\R) Change your mysql prompt.
quit      (\q) Quit mysql.
rehash    (\#) Rebuild completion hash.
source    (\.) Execute an SQL script file. Takes a file name as an argument.
status    (\s) Get status information from the server.
system    (\!) Execute a system shell command.
tee       (\T) Set outfile [to_outfile]. Append everything into given outfile.
use       (\u) Use another database. Takes database name as argument.
charset   (\C) Switch to another charset. Might be needed for processing binlog with multi-byte charsets.
warnings  (\W) Show warnings after every statement.
nowarning (\w) Don't show warnings after every statement.
resetconnection(\x) Clean session context.
query_attributes Sets string parameters (name1 value1 name2 value2 ...) for the next query to pick up.
ssl_session_data_print Serializes the current SSL session data to stdout or file

For server side help, type 'help contents'

mysql>
```

图 7: help 命令

创建一个名为 dbcourse 的数据库对象

```
create database dbcourse;
```

```
mysql> create database dbcourse;
Query OK, 1 row affected (0.01 sec)
```

图 8: 创建数据库对象

查看系统中所有的数据库对象

```
show databases;
```

```
mysql> show databases;
+--------------------+
| Database           |
+--------------------+
| dbcourse           |
| information_schema |
| mysql              |
| performance_schema |
| sys                |
+--------------------+
5 rows in set (0.00 sec)
```

图 9: 查看所有的数据库对象

将当前使用的数据库设置为 dbcourse

```
use dbcourse;
```

```
mysql> use dbcourse;
Database changed
```

图 10: 设置当前使用的数据库

接下来，执行下列 SQL 语句，在 dbcourse 数据库中创建数据表

```
create table classroom(
    building varchar(15),
    room_number varchar(7),
    capacity numeric(4,0),
    primary key (building, room_number)
);
create table department(
    dept_name varchar(20),
    building varchar(15),
    budget numeric(12,2) check (budget > 0),
    primary key (dept_name)
);
create table course(
    course_id varchar(8),
```

```sql
    title varchar(50),
    dept_name varchar(20),
    credits numeric(2,0) check (credits > 0),
    primary key (course_id),
    foreign key (dept_name) references department (dept_name)
    on delete set null
);
create table instructor(
    ID varchar(5),
    name varchar(20) not null,
    dept_name varchar(20),
    salary numeric(8,2) check (salary > 29000),
    primary key (ID),
    foreign key (dept_name) references department (dept_name)
    on delete set null
);
create table section(
    course_id varchar(8),
    sec_id varchar(8),
    semester varchar(6) check (semester in
    ('Fall', 'Winter', 'Spring', 'Summer')),
    year numeric(4,0) check (year > 1701 and year < 2100),
    building varchar(15),
    room_number varchar(7),
    time_slot_id varchar(4),
    primary key (course_id, sec_id, semester, year),
    foreign key (course_id) references course (course_id) on delete cascade,
    foreign key (building, room_number)
    references classroom (building, room_number) on delete set null
);
create table teaches(
    ID varchar(5),
    course_id varchar(8),
    sec_id varchar(8),
    semester varchar(6),
    year numeric(4,0),
    primary key (ID, course_id, sec_id, semester, year),
    foreign key (course_id, sec_id, semester, year)
    references section (course_id, sec_id, semester, year)
    on delete cascade,
    foreign key (ID) references instructor (ID) on delete cascade
);
create table student(
    ID varchar(5),
```

```sql
    name varchar(20) not null,
    dept_name varchar(20),
    tot_cred numeric(3,0) check (tot_cred >= 0),
    primary key (ID),
    foreign key (dept_name) references department (dept_name)
    on delete set null
);
create table takes(
    ID varchar(5),
    course_id varchar(8),
    sec_id varchar(8),
    semester varchar(6),
    year numeric(4,0),
    grade varchar(2),
    primary key (ID, course_id, sec_id, semester, year),
    foreign key (course_id, sec_id, semester, year)
    references section (course_id, sec_id, semester, year)
    on delete cascade,
    foreign key (ID) references student (ID) on delete cascade
);
create table advisor(
    s_ID varchar(5),
    i_ID varchar(5),
    primary key (s_ID),
    foreign key (i_ID) references instructor (ID) on delete set null,
    foreign key (s_ID) references student (ID) on delete cascade
);
create table time_slot(
    time_slot_id varchar(4),
    day varchar(1),
    start_hr numeric(2) check (start_hr >= 0 and start_hr < 24),
    start_min numeric(2) check (start_min >= 0 and start_min < 60),
    end_hr numeric(2) check (end_hr >= 0 and end_hr < 24),
    end_min numeric(2) check (end_min >= 0 and end_min < 60),
    primary key (time_slot_id, day, start_hr, start_min)
);
create table prereq(
    course_id varchar(8),
    prereq_id varchar(8),
    primary key (course_id, prereq_id),
    foreign key (course_id) references course (course_id) on delete cascade,
    foreign key (prereq_id) references course (course_id)
);
```

然后查看 dbcourse 数据库中所有的数据表

```
show tables;
```

```
mysql> show tables;
+--------------------+
| Tables_in_dbcourse |
+--------------------+
| advisor            |
| classroom          |
| course             |
| department         |
| instructor         |
| prereq             |
| section            |
| student            |
| takes              |
| teaches            |
| time_slot          |
+--------------------+
11 rows in set (0.00 sec)
```

图 11: 查看所有的表

接下来，执行下列 SQL 语句，向数据表中插入数据：

```
insert into classroom values ('Packard', '101', '500');
insert into classroom values ('Painter', '514', '10');
insert into classroom values ('Taylor', '3128', '70');
insert into classroom values ('Watson', '100', '30');
insert into classroom values ('Watson', '120', '50');
insert into department values ('Biology', 'Watson', '90000');
insert into department values ('Comp. Sci.', 'Taylor', '100000');
insert into department values ('Elec. Eng.', 'Taylor', '85000');
insert into department values ('Finance', 'Painter', '120000');
insert into department values ('History', 'Painter', '50000');
insert into department values ('Music', 'Packard', '80000');
insert into department values ('Physics', 'Watson', '70000');
insert into course values ('BIO-101', 'Intro. to Biology', 'Biology', '4');
insert into course values ('BIO-301', 'Genetics', 'Biology', '4');
insert into course values ('BIO-399', 'Computational Biology', 'Biology', '3');
insert into course values ('CS-101', 'Intro. to Computer Science', 'Comp. Sci.', '4'
    );
insert into course values ('CS-190', 'Game Design', 'Comp. Sci.', '4');
insert into course values ('CS-315', 'Robotics', 'Comp. Sci.', '3');
```

```sql
insert into course values ('CS-319', 'Image Processing', 'Comp. Sci.', '3');
insert into course values ('CS-347', 'Database System Concepts', 'Comp. Sci.', '3');
insert into course values ('EE-181', 'Intro. to Digital Systems', 'Elec. Eng.', '3');
insert into course values ('FIN-201', 'Investment Banking', 'Finance', '3');
insert into course values ('HIS-351', 'World History', 'History', '3');
insert into course values ('MU-199', 'Music Video Production', 'Music', '3');
insert into course values ('PHY-101', 'Physical Principles', 'Physics', '4');
insert into instructor values ('10101', 'Srinivasan', 'Comp. Sci.', '65000');
insert into instructor values ('12121', 'Wu', 'Finance', '90000');
insert into instructor values ('15151', 'Mozart', 'Music', '40000');
insert into instructor values ('22222', 'Einstein', 'Physics', '95000');
insert into instructor values ('32343', 'El Said', 'History', '60000');
insert into instructor values ('33456', 'Gold', 'Physics', '87000');
insert into instructor values ('45565', 'Katz', 'Comp. Sci.', '75000');
insert into instructor values ('58583', 'Califieri', 'History', '62000');
insert into instructor values ('76543', 'Singh', 'Finance', '80000');
insert into instructor values ('76766', 'Crick', 'Biology', '72000');
insert into instructor values ('83821', 'Brandt', 'Comp. Sci.', '92000');
insert into instructor values ('98345', 'Kim', 'Elec. Eng.', '80000');
insert into section values ('BIO-101', '1', 'Summer', '2017', 'Painter', '514', 'B');
insert into section values ('BIO-301', '1', 'Summer', '2018', 'Painter', '514', 'A');
insert into section values ('CS-101', '1', 'Fall', '2017', 'Packard', '101', 'H');
insert into section values ('CS-101', '1', 'Spring', '2018', 'Packard', '101', 'F');
insert into section values ('CS-190', '1', 'Spring', '2017', 'Taylor', '3128', 'E');
insert into section values ('CS-190', '2', 'Spring', '2017', 'Taylor', '3128', 'A');
insert into section values ('CS-315', '1', 'Spring', '2018', 'Watson', '120', 'D');
insert into section values ('CS-319', '1', 'Spring', '2018', 'Watson', '100', 'B');
insert into section values ('CS-319', '2', 'Spring', '2018', 'Taylor', '3128', 'C');
insert into section values ('CS-347', '1', 'Fall', '2017', 'Taylor', '3128', 'A');
insert into section values ('EE-181', '1', 'Spring', '2017', 'Taylor', '3128', 'C');
insert into section values ('FIN-201', '1', 'Spring', '2018', 'Packard', '101', 'B');
insert into section values ('HIS-351', '1', 'Spring', '2018', 'Painter', '514', 'C');
insert into section values ('MU-199', '1', 'Spring', '2018', 'Packard', '101', 'D');
insert into section values ('PHY-101', '1', 'Fall', '2017', 'Watson', '100', 'A');
insert into teaches values ('10101', 'CS-101', '1', 'Fall', '2017');
insert into teaches values ('10101', 'CS-315', '1', 'Spring', '2018');
insert into teaches values ('10101', 'CS-347', '1', 'Fall', '2017');
insert into teaches values ('12121', 'FIN-201', '1', 'Spring', '2018');
insert into teaches values ('15151', 'MU-199', '1', 'Spring', '2018');
```

```sql
insert into teaches values ('22222', 'PHY-101', '1', 'Fall', '2017');
insert into teaches values ('32343', 'HIS-351', '1', 'Spring', '2018');
insert into teaches values ('45565', 'CS-101', '1', 'Spring', '2018');
insert into teaches values ('45565', 'CS-319', '1', 'Spring', '2018');
insert into teaches values ('76766', 'BIO-101', '1', 'Summer', '2017');
insert into teaches values ('76766', 'BIO-301', '1', 'Summer', '2018');
insert into teaches values ('83821', 'CS-190', '1', 'Spring', '2017');
insert into teaches values ('83821', 'CS-190', '2', 'Spring', '2017');
insert into teaches values ('83821', 'CS-319', '2', 'Spring', '2018');
insert into teaches values ('98345', 'EE-181', '1', 'Spring', '2017');
insert into student values ('00128', 'Zhang', 'Comp. Sci.', '102');
insert into student values ('12345', 'Shankar', 'Comp. Sci.', '32');
insert into student values ('19991', 'Brandt', 'History', '80');
insert into student values ('23121', 'Chavez', 'Finance', '110');
insert into student values ('44553', 'Peltier', 'Physics', '56');
insert into student values ('45678', 'Levy', 'Physics', '46');
insert into student values ('54321', 'Williams', 'Comp. Sci.', '54');
insert into student values ('55739', 'Sanchez', 'Music', '38');
insert into student values ('70557', 'Snow', 'Physics', '0');
insert into student values ('76543', 'Brown', 'Comp. Sci.', '58');
insert into student values ('76653', 'Aoi', 'Elec. Eng.', '60');
insert into student values ('98765', 'Bourikas', 'Elec. Eng.', '98');
insert into student values ('98988', 'Tanaka', 'Biology', '120');
insert into takes values ('00128', 'CS-101', '1', 'Fall', '2017', 'A');
insert into takes values ('00128', 'CS-347', '1', 'Fall', '2017', 'A-');
insert into takes values ('12345', 'CS-101', '1', 'Fall', '2017', 'C');
insert into takes values ('12345', 'CS-190', '2', 'Spring', '2017', 'A');
insert into takes values ('12345', 'CS-315', '1', 'Spring', '2018', 'A');
insert into takes values ('12345', 'CS-347', '1', 'Fall', '2017', 'A');
insert into takes values ('19991', 'HIS-351', '1', 'Spring', '2018', 'B');
insert into takes values ('23121', 'FIN-201', '1', 'Spring', '2018', 'C+');
insert into takes values ('44553', 'PHY-101', '1', 'Fall', '2017', 'B-');
insert into takes values ('45678', 'CS-101', '1', 'Fall', '2017', 'F');
insert into takes values ('45678', 'CS-101', '1', 'Spring', '2018', 'B+');
insert into takes values ('45678', 'CS-319', '1', 'Spring', '2018', 'B');
insert into takes values ('54321', 'CS-101', '1', 'Fall', '2017', 'A-');
insert into takes values ('54321', 'CS-190', '2', 'Spring', '2017', 'B+');
insert into takes values ('55739', 'MU-199', '1', 'Spring', '2018', 'A-');
insert into takes values ('76543', 'CS-101', '1', 'Fall', '2017', 'A');
insert into takes values ('76543', 'CS-319', '2', 'Spring', '2018', 'A');
insert into takes values ('76653', 'EE-181', '1', 'Spring', '2017', 'C');
insert into takes values ('98765', 'CS-101', '1', 'Fall', '2017', 'C-');
insert into takes values ('98765', 'CS-315', '1', 'Spring', '2018', 'B');
insert into takes values ('98988', 'BIO-101', '1', 'Summer', '2017', 'A');
```

```sql
insert into takes values ('98988', 'BIO-301', '1', 'Summer', '2018', null);
insert into advisor values ('00128', '45565');
insert into advisor values ('12345', '10101');
insert into advisor values ('23121', '76543');
insert into advisor values ('44553', '22222');
insert into advisor values ('45678', '22222');
insert into advisor values ('76543', '45565');
insert into advisor values ('76653', '98345');
insert into advisor values ('98765', '98345');
insert into advisor values ('98988', '76766');
insert into time_slot values ('A', 'M', '8', '0', '8', '50');
insert into time_slot values ('A', 'W', '8', '0', '8', '50');
insert into time_slot values ('A', 'F', '8', '0', '8', '50');
insert into time_slot values ('B', 'M', '9', '0', '9', '50');
insert into time_slot values ('B', 'W', '9', '0', '9', '50');
insert into time_slot values ('B', 'F', '9', '0', '9', '50');
insert into time_slot values ('C', 'M', '11', '0', '11', '50');
insert into time_slot values ('C', 'W', '11', '0', '11', '50');
insert into time_slot values ('C', 'F', '11', '0', '11', '50');
insert into time_slot values ('D', 'M', '13', '0', '13', '50');
insert into time_slot values ('D', 'W', '13', '0', '13', '50');
insert into time_slot values ('D', 'F', '13', '0', '13', '50');
insert into time_slot values ('E', 'T', '10', '30', '11', '45 ');
insert into time_slot values ('E', 'R', '10', '30', '11', '45 ');
insert into time_slot values ('F', 'T', '14', '30', '15', '45 ');
insert into time_slot values ('F', 'R', '14', '30', '15', '45 ');
insert into time_slot values ('G', 'M', '16', '0', '16', '50');
insert into time_slot values ('G', 'W', '16', '0', '16', '50');
insert into time_slot values ('G', 'F', '16', '0', '16', '50');
insert into time_slot values ('H', 'W', '10', '0', '12', '30');
insert into prereq values ('BIO-301', 'BIO-101');
insert into prereq values ('BIO-399', 'BIO-101');
insert into prereq values ('CS-190', 'CS-101');
insert into prereq values ('CS-315', 'CS-101');
insert into prereq values ('CS-319', 'CS-101');
insert into prereq values ('CS-347', 'CS-101');
insert into prereq values ('EE-181', 'PHY-101');
```

执行下列 SQL 语句，查询每张数据表中的数据：

```sql
select * from advisor;
select * from classroom;
select * from course;
select * from department;
```

```
select * from instructor;
select * from prereq;
select * from section;
select * from student;
select * from takes;
select * from teaches;
select * from time_slot;
```

```
mysql> select * from time_slot;
+--------------+-----+-----------+------------+---------+---------+
| time_slot_id | day | start_hr | start_min | end_hr | end_min |
+--------------+-----+-----------+------------+---------+---------+
| A            | F   |         8 |          0 |       8 |      50 |
| A            | M   |         8 |          0 |       8 |      50 |
| A            | W   |         8 |          0 |       8 |      50 |
| B            | F   |         9 |          0 |       9 |      50 |
| B            | M   |         9 |          0 |       9 |      50 |
| B            | W   |         9 |          0 |       9 |      50 |
| C            | F   |        11 |          0 |      11 |      50 |
| C            | M   |        11 |          0 |      11 |      50 |
| C            | W   |        11 |          0 |      11 |      50 |
| D            | F   |        13 |          0 |      13 |      50 |
| D            | M   |        13 |          0 |      13 |      50 |
| D            | W   |        13 |          0 |      13 |      50 |
| E            | R   |        10 |         30 |      11 |      45 |
| E            | T   |        10 |         30 |      11 |      45 |
| F            | R   |        14 |         30 |      15 |      45 |
| F            | T   |        14 |         30 |      15 |      45 |
| G            | F   |        16 |          0 |      16 |      50 |
| G            | M   |        16 |          0 |      16 |      50 |
| G            | W   |        16 |          0 |      16 |      50 |
| H            | W   |        10 |          0 |      12 |      30 |
+--------------+-----+-----------+------------+---------+---------+
20 rows in set (0.00 sec)
```

图 12: 查询表中的数据

使用 `describe` 命令查看数据表的结构：

```
describe advisor;
```

```
mysql> describe advisor;
+-------+-------------+------+-----+---------+-------+
| Field | Type        | Null | Key | Default | Extra |
+-------+-------------+------+-----+---------+-------+
| s_ID  | varchar(5)  | NO   | PRI | NULL    |       |
| i_ID  | varchar(5)  | YES  | MUL | NULL    |       |
+-------+-------------+------+-----+---------+-------+
2 rows in set (0.05 sec)
```

图 13: 查看表的结构

使用 show index from 语句查看数据表的索引信息

```
show index from advisor;
```

```
mysql> show index from advisor;
+---------+------------+----------+--------------+-------------+-----------+-------------+----------+--------+------+------------+---------+---------------+---------+------------+
| Table   | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+---------+------------+----------+--------------+-------------+-----------+-------------+----------+--------+------+------------+---------+---------------+---------+------------+
| advisor |          0 | PRIMARY  |            1 | s_ID        | A         |           9 |     NULL |   NULL |      | BTREE      |         |               | YES     | NULL       |
| advisor |          1 | i_ID     |            1 | i_ID        | A         |           6 |     NULL |   NULL | YES  | BTREE      |         |               | YES     | NULL       |
+---------+------------+----------+--------------+-------------+-----------+-------------+----------+--------+------+------------+---------+---------------+---------+------------+
2 rows in set (0.02 sec)
```

图 14: 查看表的索引

将当前使用的数据库设置为 mysql

```
use mysql;
```

查看 mysql 数据库中的所有数据表对象

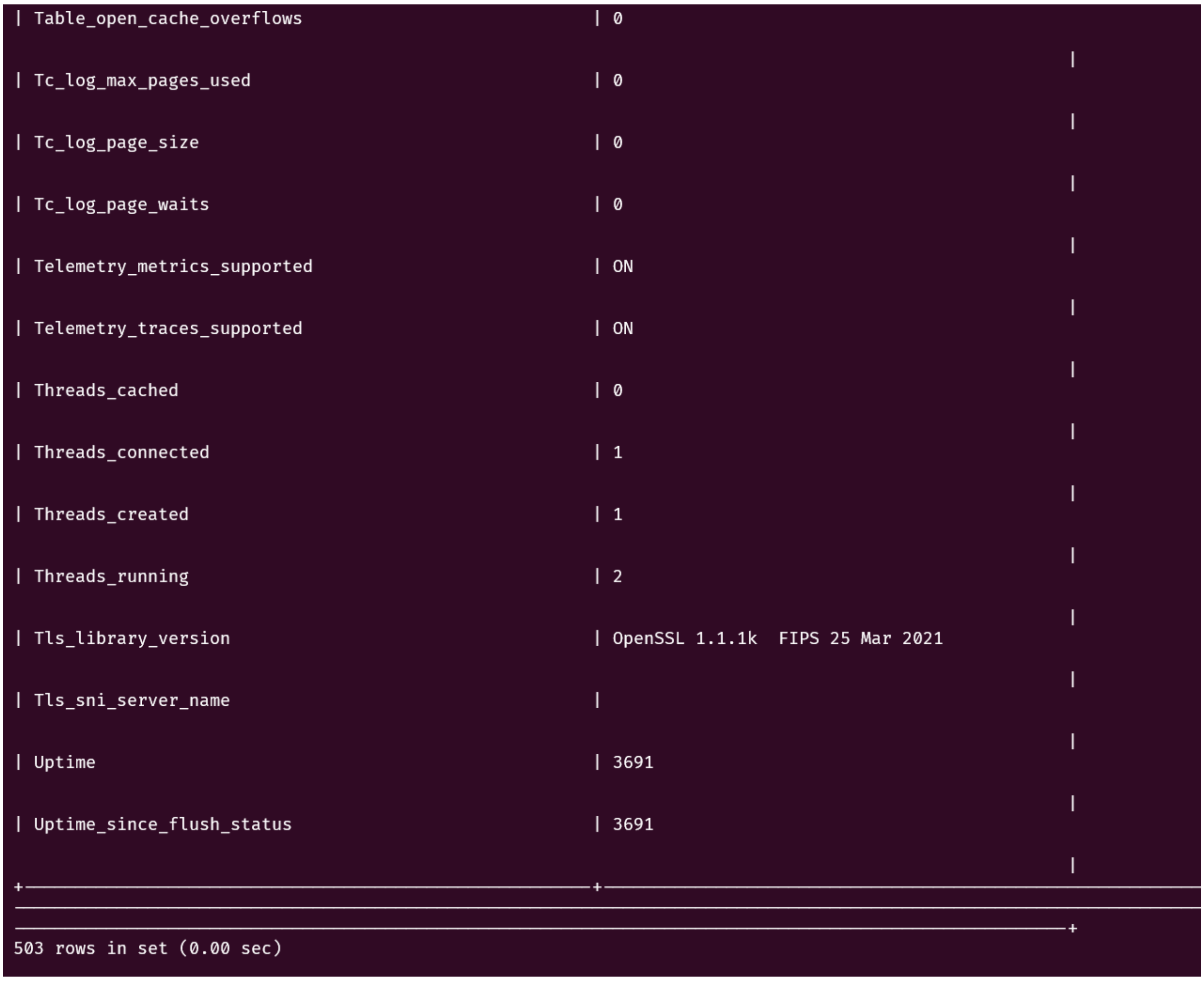
```
show tables;
```

```
mysql> show tables;
+-------------------------------------------------------+
| Tables_in_mysql                                       |
+-------------------------------------------------------+
| columns_priv                                          |
| component                                             |
| db                                                    |
| default_roles                                         |
| engine_cost                                           |
| func                                                  |
| general_log                                           |
| global_grants                                         |
| gtid_executed                                         |
| help_category                                         |
| help_keyword                                          |
| help_relation                                         |
| help_topic                                            |
| innodb_index_stats                                    |
| innodb_table_stats                                    |
| ndb_binlog_index                                      |
| password_history                                      |
| plugin                                                |
| procs_priv                                            |
| proxies_priv                                          |
| replication_asynchronous_connection_failover          |
| replication_asynchronous_connection_failover_managed  |
| replication_group_configuration_version               |
| replication_group_member_actions                      |
| role_edges                                            |
| server_cost                                           |
| servers                                               |
| slave_master_info                                     |
| slave_relay_log_info                                  |
| slave_worker_info                                     |
| slow_log                                              |
| tables_priv                                           |
| time_zone                                             |
| time_zone_leap_second                                 |
| time_zone_name                                        |
| time_zone_transition                                  |
| time_zone_transition_type                             |
| user                                                  |
+-------------------------------------------------------+
38 rows in set (0.00 sec)
```

图 15: 查看 mysql 数据库中的所有数据表对象

查看数据库服务的状态

```
show status;
```

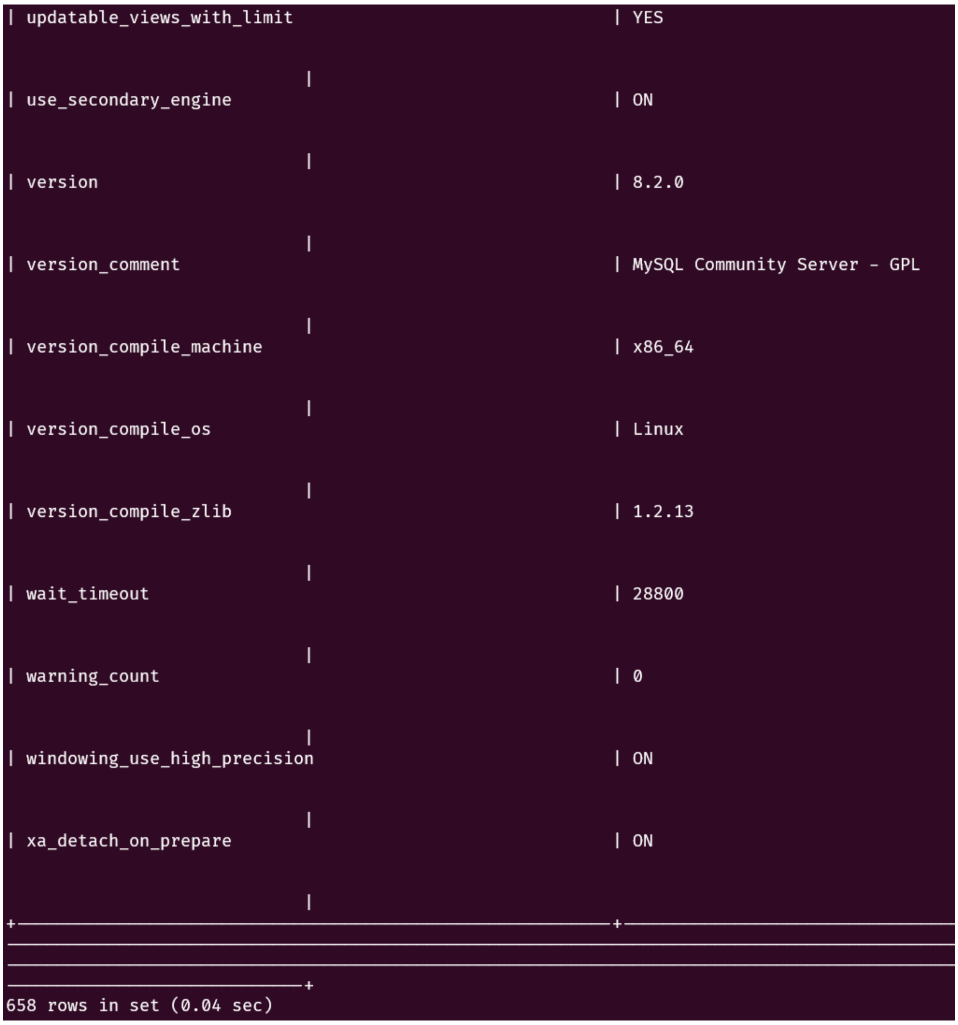


```
| Table_open_cache_overflows                          | 0
                                                                                             |
| Tc_log_max_pages_used                               | 0
                                                                                             |
| Tc_log_page_size                                    | 0
                                                                                             |
| Tc_log_page_waits                                   | 0
                                                                                             |
| Telemetry_metrics_supported                         | ON
                                                                                             |
| Telemetry_traces_supported                          | ON
                                                                                             |
| Threads_cached                                      | 0
                                                                                             |
| Threads_connected                                   | 1
                                                                                             |
| Threads_created                                     | 1
                                                                                             |
| Threads_running                                     | 2
                                                                                             |
| Tls_library_version                                 | OpenSSL 1.1.1k  FIPS 25 Mar 2021
                                                                                             |
| Tls_sni_server_name                                 |
                                                                                             |
| Uptime                                              | 3691
                                                                                             |
| Uptime_since_flush_status                           | 3691
                                                                                             |
+-----------------------------------------------------+----------------------------------------------------------
------------------------------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------+
503 rows in set (0.00 sec)
```

图 16: 查看数据库服务的状态

命令查询系统变量的值

```
show variables;
```

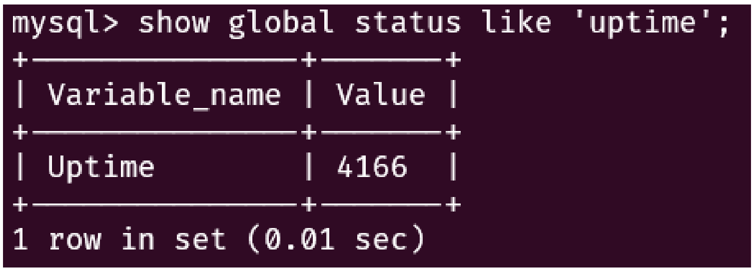


```
| updatable_views_with_limit                             | YES

                             |
| use_secondary_engine                                   | ON

                             |
| version                                                | 8.2.0

                             |
| version_comment                                        | MySQL Community Server - GPL

                             |
| version_compile_machine                                | x86_64

                             |
| version_compile_os                                     | Linux

                             |
| version_compile_zlib                                   | 1.2.13

                             |
| wait_timeout                                           | 28800

                             |
| warning_count                                          | 0

                             |
| windowing_use_high_precision                           | ON

                             |
| xa_detach_on_prepare                                   | ON

                             |
+--------------------------------------------------------+-----------------------------
-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------
-----------------------------+
658 rows in set (0.04 sec)
```

图 17: 查询系统变量的值

查询数据库服务的启动时间

```
show global status like 'uptime';
```



```
mysql> show global status like 'uptime';
+---------------+-------+
| Variable_name | Value |
+---------------+-------+
| Uptime        | 4166  |
+---------------+-------+
1 row in set (0.01 sec)
```

图 18: 查询数据库服务的启动时间

查询系统中的当前时间戳

```
select unix_timestamp();
```

```
mysql> select unix_timestamp();
+------------------+
| unix_timestamp() |
+------------------+
|       1710955749 |
+------------------+
1 row in set (0.00 sec)
```

图 19: 查询系统中的当前时间戳

查询 MySQL 数据库服务的版本、当前日期、当前时间、当前用户和所使用的数据库

```
select version(), curdate(), curtime(), current_user(), database();
```

```
mysql> select version(), curdate(), curtime(), current_user(), database();
+-----------+------------+-----------+----------------+-------------+
| version() | curdate()  | curtime() | current_user() | database() |
+-----------+------------+-----------+----------------+-------------+
| 8.2.0     | 2024-03-20 | 17:34:02  | root@localhost | mysql       |
+-----------+------------+-----------+----------------+-------------+
1 row in set (0.01 sec)
```

图 20: 查询相关内容

退出 MySQL

```
exit;
```

退出 bash

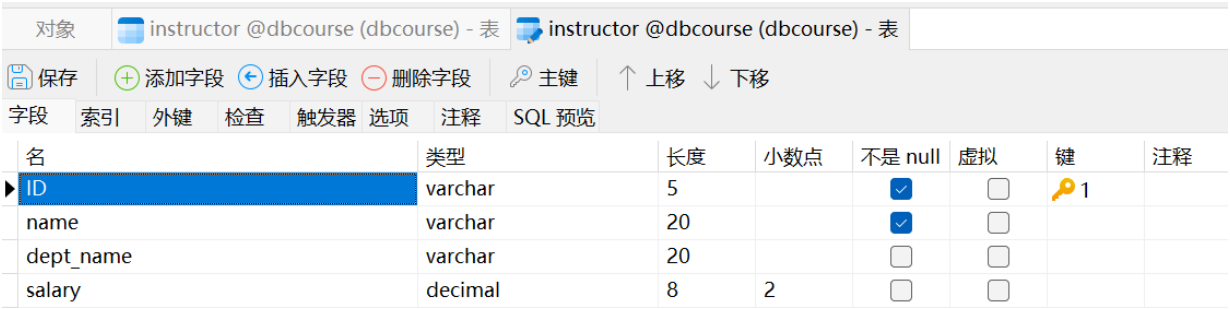
```
exit
```

2.4 通过图形工具 Navicat 连接并操作 MySQL 数据库

在 Navicat 中新建一个连接，连接到 MySQL 数据库：

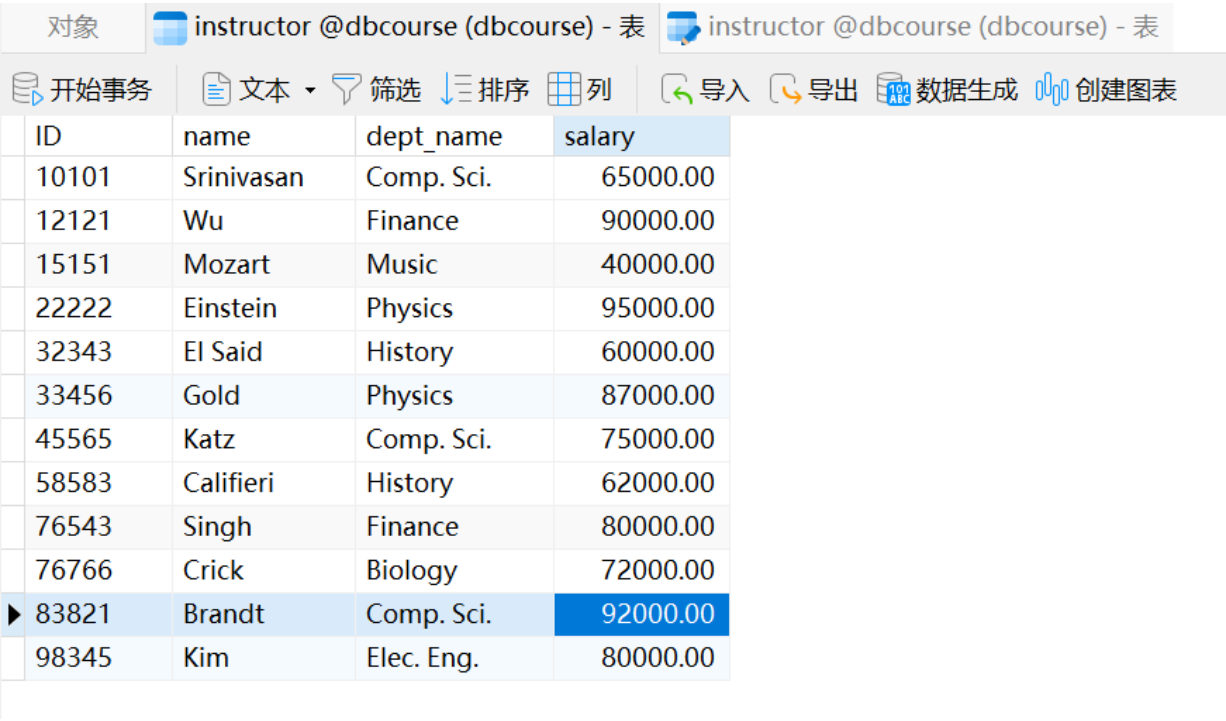
图 21: 新建连接

连接成功后，通过 `Navicat` 的图形界面查看数据表 `instrctor` 的结构和内容



名	类型	长度	小数点	不是 null	虚拟	键	注释
ID	varchar	5		☑	☐	🔑 1	
name	varchar	20		☑	☐		
dept_name	varchar	20		☐	☐		
salary	decimal	8	2	☐	☐		

图 22: 结构



ID	name	dept_name	salary
10101	Srinivasan	Comp. Sci.	65000.00
12121	Wu	Finance	90000.00
15151	Mozart	Music	40000.00
22222	Einstein	Physics	95000.00
32343	El Said	History	60000.00
33456	Gold	Physics	87000.00
45565	Katz	Comp. Sci.	75000.00
58583	Califieri	History	62000.00
76543	Singh	Finance	80000.00
76766	Crick	Biology	72000.00
83821	Brandt	Comp. Sci.	92000.00
98345	Kim	Elec. Eng.	80000.00

图 23: 内容

通过 `Navicat` 的图形界面创建一个名为 `dbtest` 的数据库，在其中创建与 `dbcourse` 数据库相同的数据表，并导入相同的数据

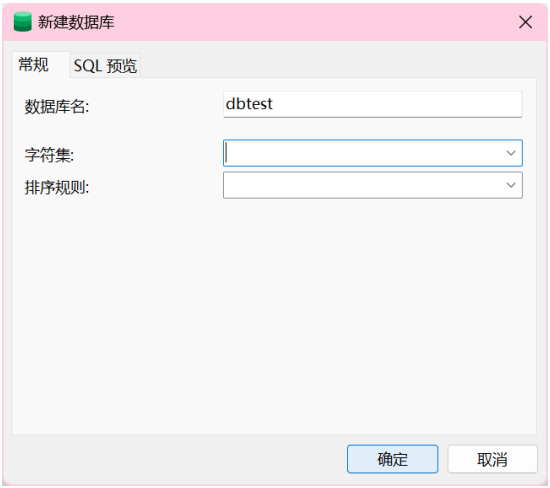


图 24: 创建数据库

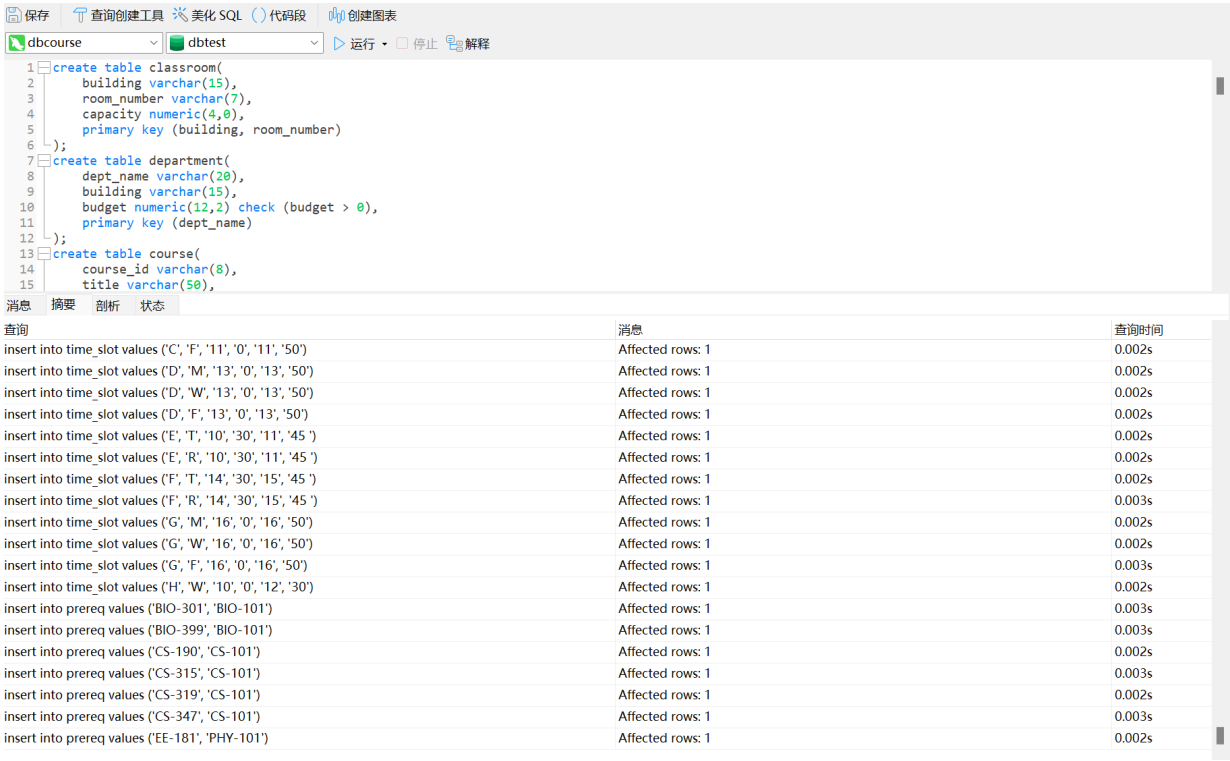


图 25: 执行相关 SQL 语句

2.5 Docker 常用操作

查看系统中所有的的容器信息

```
sudo docker ps -a
```

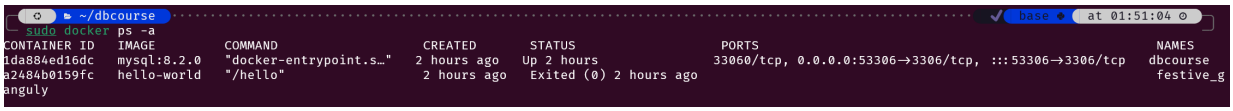


图 26: 查看所有的的容器信息

将容器打包为镜像

```
sudo docker commit dbcourse dbcourse:v1
```

```
~/dbcourse
sudo docker commit dbcourse dbcourse:v1
sha256:572e5591ca7ebd577bc2b945fd080a58a9073f7484075b266d2cc3e8944c6b6d
```

图 27: 将容器打包为镜像

查看本地仓库中的镜像

```
sudo docker images
```

```
~/dbcourse
sudo docker images
REPOSITORY    TAG       IMAGE ID       CREATED          SIZE
dbcourse      v1        572e5591ca7e   49 seconds ago   619MB
mysql         8.2.0     bc861cf238f2   3 months ago     619MB
hello-world   latest    d2c94e258dcb   10 months ago    13.3kB
```

图 28: 本地仓库中的镜像

将镜像 dbcourse 保存为文件

```
sudo docker save -o dbcourse.tar dbcourse
```

```
~/dbcourse
sudo docker save -o dbcourse.tar dbcourse

~/dbcourse
ls
datadir  dbcourse.tar
```

图 29: 将镜像 dbcourse 保存为文件

将本地仓库中的镜像 dbcourse 删除

```
sudo docker image rm dbcourse:v1
```

```
~/dbcourse
sudo docker image rm dbcourse:v1
Untagged: dbcourse:v1
Deleted: sha256:572e5591ca7ebd577bc2b945fd080a58a9073f7484075b266d2cc3e8944c6b6d
Deleted: sha256:f46ca4b7cc225dec255634c2ee129f8acef35d946dd7f6d195f4adb82957b4ee
```

图 30: 删除镜像

停止容器 dbcourse 的运行

```
sudo docker stop dbcourse
```

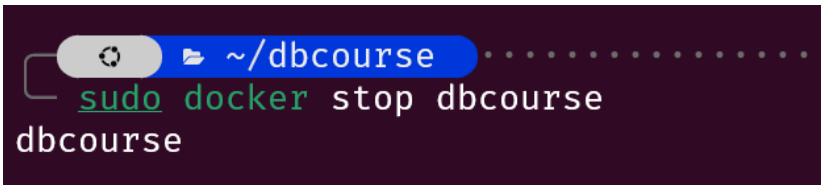


图 31: 停止容器的运行

删除容器 dbcourse

```
sudo docker rm dbcourse
```

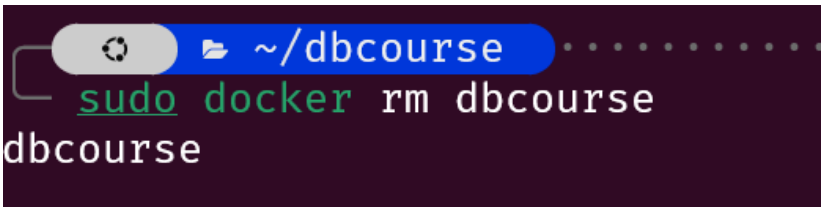


图 32: 删除容器

将镜像文件加载到本地仓库

```
sudo docker load --input dbcourse.tar
```

图 33: 加载镜像文件

3 存在的问题及解决方案

在实验中，运行插入数据的 SQL 语句时，发生错误。经检查，是由于在复制 SQL 语句时，发生了在字符串中央的意外换行，导致 MySQL 无法识别。解决方案是将 SQL 语句复制到文本编辑器中，检查并删除意外的换行。

4 实验小结

通过本次实验，我学习了 Docker 的基本操作，掌握了通过 Docker 容器启动 MySQL 数据库实例，并连接和操作 MySQL 数据库的基本命令。同时，我还学会了使用 Navicat 连接并操作 MySQL 数据库，以及 Docker 的其他常用操作。这些知识对我今后的学习和工作都有很大的帮助。