A Database for an Electronic Medical Record System

Student Clinic Module
Project-2

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Requirement Specification

Student Clinic is the database project designed to facilitate student health record in a university. This system will be used by the doctor and clinic staff in the student health center of the university. It is developed to improve the clinic management and automates the workflow that happens in a student clinic. It will make it easier for the retrieval of history information of the student.

In this project, we have added few more tables to enhance the database and make it more efficient. We have added appointment table and receptionist table.
When the student will visit on clinic, he will connect with the receptionist where they will be asked to provide their name, date of birth, contact number, address and type of problems. Student will make registration first. If the student never registered before, student information is collected and stored in the database. Now, the receptionist creates an appointment for the student and student is then assigned to the doctor, which may yield to diagnosis of the disease based on the problem category.

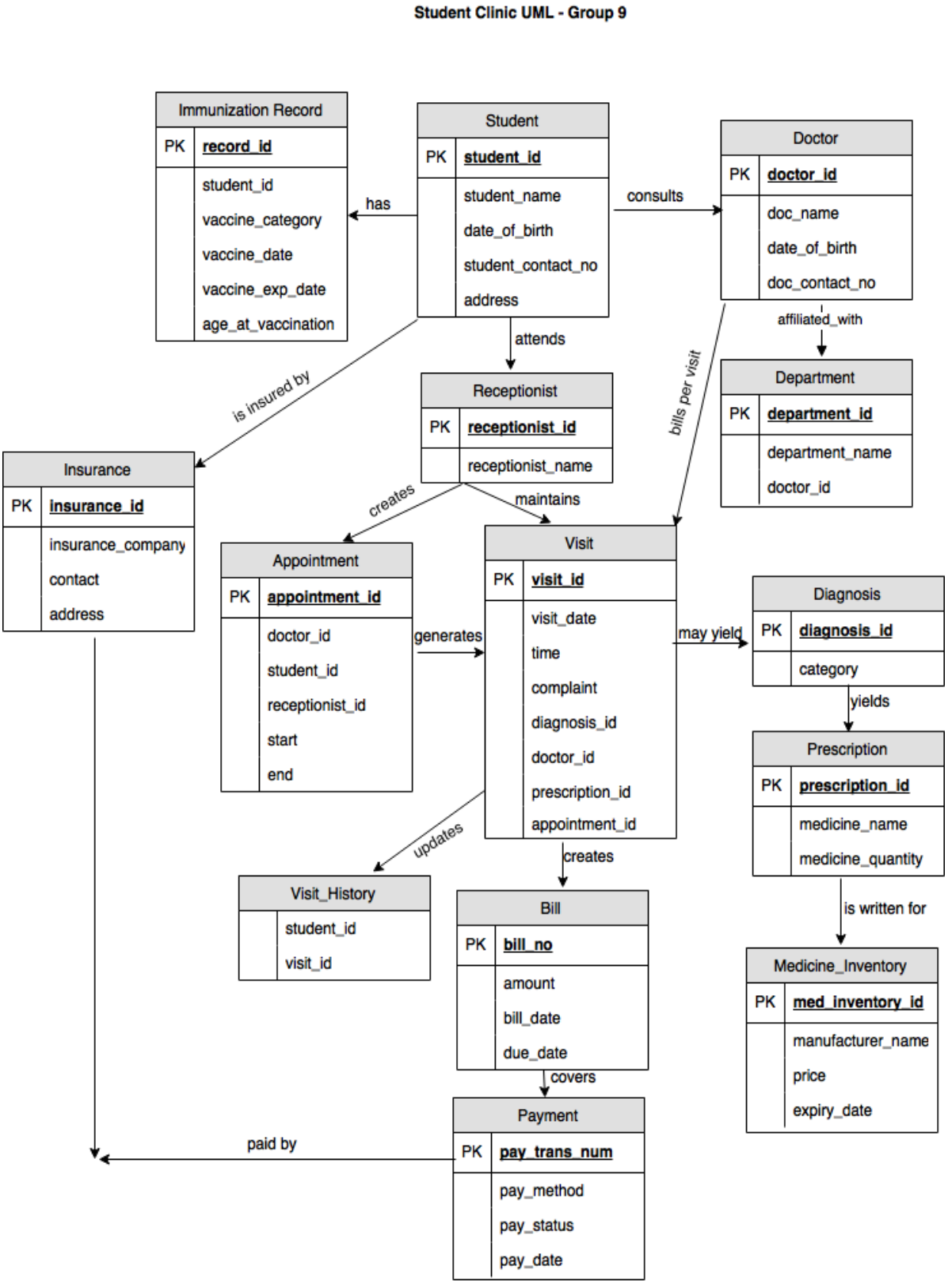
This diagnosis may further yield to treatment and doctor will then prescribe medicines which contains the medicine name, duration and quantity. Once the student gets the treatment, the doctor will send the report to the clinical staff.

The staff will view the report and complete the student record. After that, the staff will prepare the bills for the student. Student will also provide with an option for making payments. They can make their payments either by self or by medical insurance. Student will also have their immunization record maintained by clinical staff. It is easy for the management to maintain record about the student, the time for retrieving the information needed will be less compare to the manual. Then the staff will update the visit information and the student record will be kept in database.

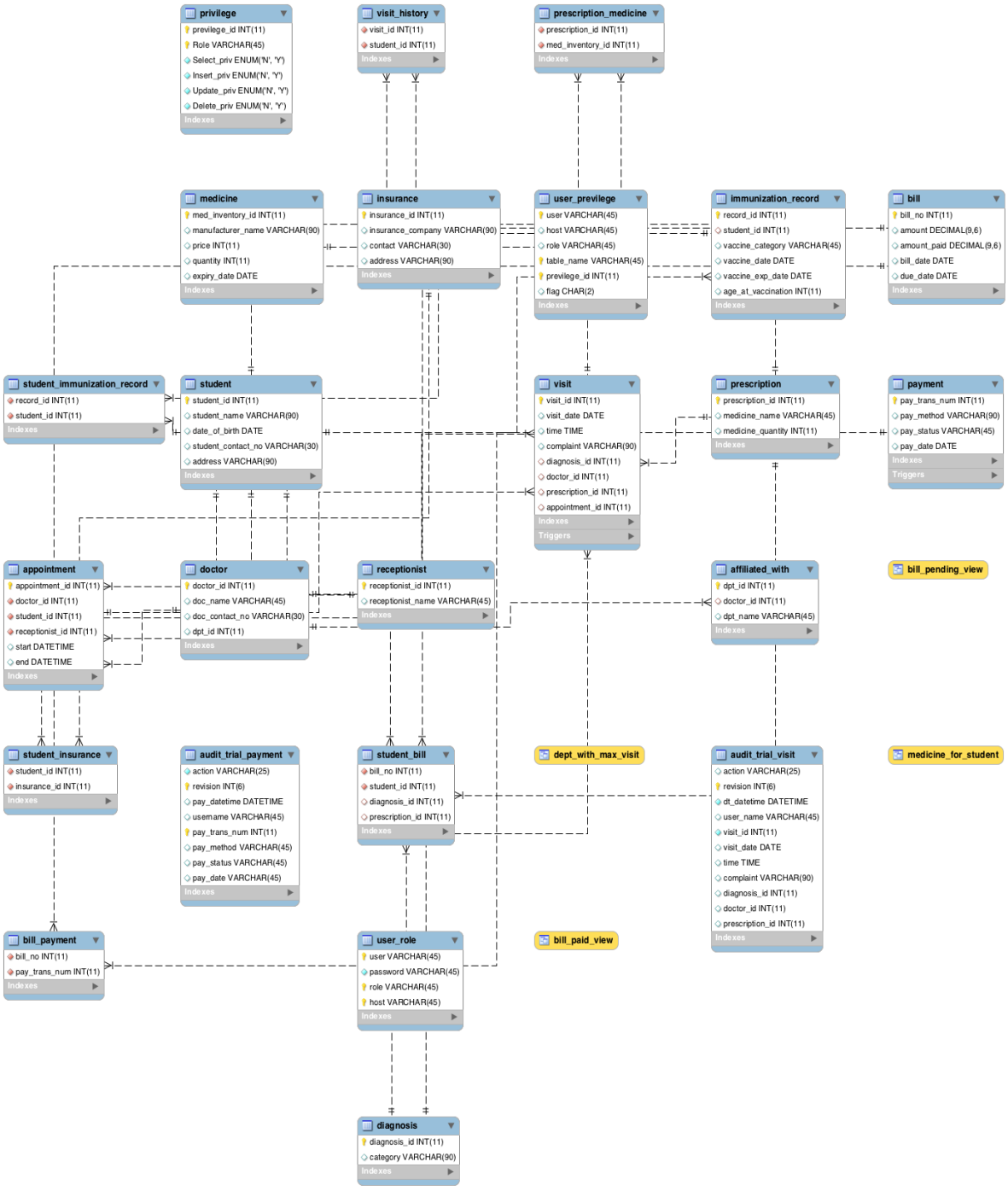
Features

- We have implemented stored procedures in the form of API that allows an EMR system developer to work with the database without having to write SQL statements.
- We have also provided security feature wherein only the authorized users will be able to access the database.
- In addition to that, we have also implemented privacy features in the form of role based access control to limit the functions the user can perform.
- To achieve the regulatory requirements, we have added audit trial feature for the transactional tables wherein the logs for every change to the database made are captured.
- To optimize the performance further, we have implemented the usage of views indexes and views.

UML Data Model



ER Diagram


privilege
previlege_id INT(11)
Role VARCHAR(45)
Select_priv ENUM('N', 'Y')
Insert_priv ENUM('N', 'Y')
Update_priv ENUM('N', 'Y')
Delete_priv ENUM('N', 'Y')
Indexes
visit_history
visit_id INT(11)
student_id INT(11)
Indexes
prescription_medicine
prescription_id INT(11)
med_inventory_id INT(11)
Indexes
medicine
med_inventory_id INT(11)
manufacturer_name VARCHAR(90)
price INT(11)
quantity INT(11)
expiry_date DATE
Indexes
insurance
insurance_id INT(11)
insurance_company VARCHAR(90)
contact VARCHAR(30)
address VARCHAR(90)
Indexes
user_previlege
user VARCHAR(45)
host VARCHAR(45)
role VARCHAR(45)
table_name VARCHAR(45)
previlege_id INT(11)
flag CHAR(2)
Indexes
immunization_record
record_id INT(11)
student_id INT(11)
vaccine_category VARCHAR(45)
vaccine_date DATE
vaccine_exp_date DATE
age_at_vaccination INT(11)
Indexes
bill
bill_no INT(11)
amount DECIMAL(9,6)
amount_paid DECIMAL(9,6)
bill_date DATE
due_date DATE
Indexes
student_immunization_record
record_id INT(11)
student_id INT(11)
Indexes
student
student_id INT(11)
student_name VARCHAR(90)
date_of_birth DATE
student_contact_no VARCHAR(30)
address VARCHAR(90)
Indexes
visit
visit_id INT(11)
visit_date DATE
time TIME
complaint VARCHAR(90)
diagnosis_id INT(11)
doctor_id INT(11)
prescription_id INT(11)
appointment_id INT(11)
Indexes
Triggers
prescription
prescription_id INT(11)
medicine_name VARCHAR(45)
medicine_quantity INT(11)
Indexes
payment
pay_trans_num INT(11)
pay_method VARCHAR(90)
pay_status VARCHAR(45)
pay_date DATE
Indexes
Triggers
appointment
appointment_id INT(11)
doctor_id INT(11)
student_id INT(11)
receptionist_id INT(11)
start DATETIME
end DATETIME
Indexes
doctor
doctor_id INT(11)
doc_name VARCHAR(45)
doc_contact_no VARCHAR(30)
dpt_id INT(11)
Indexes
receptionist
receptionist_id INT(11)
receptionist_name VARCHAR(45)
Indexes
affiliated_with
dpt_id INT(11)
doctor_id INT(11)
dpt_name VARCHAR(45)
Indexes
bill_pending_view
student_insurance
student_id INT(11)
insurance_id INT(11)
Indexes
audit_trial_payment
action VARCHAR(25)
revision INT(6)
pay_datetime DATETIME
username VARCHAR(45)
pay_trans_num INT(11)
pay_method VARCHAR(45)
pay_status VARCHAR(45)
pay_date VARCHAR(45)
Indexes
student_bill
bill_no INT(11)
student_id INT(11)
diagnosis_id INT(11)
prescription_id INT(11)
Indexes
dept_with_max_visit
audit_trial_visit
action VARCHAR(25)
revision INT(6)
dt_datetime DATETIME
user_name VARCHAR(45)
visit_id INT(11)
visit_date DATE
time TIME
complaint VARCHAR(90)
diagnosis_id INT(11)
doctor_id INT(11)
prescription_id INT(11)
Indexes
medicine_for_student
bill_payment
bill_no INT(11)
pay_trans_num INT(11)
Indexes
user_role
user VARCHAR(45)
password VARCHAR(45)
role VARCHAR(45)
host VARCHAR(45)
Indexes
bill_paid_view
diagnosis
diagnosis_id INT(11)
category VARCHAR(90)
Indexes

Procedures for database insertion and modification

Insert Procedure

To insert new doctor data

```
DELIMITER $$
CREATE PROCEDURE `NewDoctor_insert`
(IN DOCTOR_ID varchar(12),
IN DOCTOR_NAME varchar(45),
IN DOCTOR_CONTACT varchar(30))
BEGIN
INSERT INTO doctor(doctor_id,doc_name,doc_contact_no)
values(DOCTOR_ID,DOCTOR_NAME,DOCTOR_CONTACT);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`NewDoctor_insert`('108', 'Dr.Jake', '9803655355');
```

To insert new student data

```
DELIMITER $$
CREATE PROCEDURE `NewStudent_INSERT`(IN Student_ID varchar(12),
IN Student_Name varchar(90),
IN Student_DOB date,
IN Student_Contact varchar(30),
IN Student_Address varchar(90)
)
BEGIN
INSERT INTO student
values(Student_ID,Student_Name,Student_DOB,Student_Contact,Student_Address);
END$$
DELIMITER ;

SET @Student_ID='55';
SET @Student_Name='Harika';
SET @Student_DOB='1993-01-02';
SET @Student_Contact='9803650355';
SET @Student_Address='UTD,NC';

CALL
`student_clinic_db_final`.`NewStudent_INSERT`(@Student_ID,@Student_Name,@Student_DO
B,@Student_Contact,@Student_Address);
```

To insert new insurance company

```
DELIMITER $$
CREATE PROCEDURE `InsuranceCompany_insert`(IN COMPANY_ID varchar(12),
IN  COMPANY_NAME varchar(45),
IN COMPANY_CONTACT varchar(30),
IN COMPANY_ADDRESS varchar(90)
)
BEGIN
INSERT INTO insurance(insurance_id,insurance_company,contact,address)
values(COMPANY_ID,COMPANY_NAME,COMPANY_CONTACT,COMPANY_ADDRESS);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`InsuranceCompany_insert`('50','ISO','7645423457','ABCD');
```

To insert the visit information

```
DELIMITER $$
CREATE PROCEDURE `VISIT_insert`
(IN VISIT_ID varchar(11),
IN VISIT_DATE date,
IN VISIT_TIME time,
IN VISIT_COMPLAINT varchar(90),
IN DIAGNOSIS_ID varchar(11),
IN DOC_ID varchar(12),
IN PRESCR_ID varchar(11)
)
BEGIN
INSERT INTO visit(visit_id,visit_date,time,complaint,diagnosis_id,doctor_id,prescription_id)
 values(VISIT_ID,VISIT_DATE,VISIT_TIME,VISIT_COMPLAINT,DIAGNOSIS_ID,DOC_ID,PRESCR_ID);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`VISIT_insert`('6','2017-05-03','01:00:00','Throat
infection','14','101','12');
```

To enter new diagnosis record

```
DELIMITER $$
CREATE PROCEDURE `New_diagnosis`
(IN DIAGNOSIS_ID varchar(12),IN  DIAGNOSIS_CATEGORY varchar(45))
BEGIN
INSERT INTO diagnosis(diagnosis_id,category) values(DIAGNOSIS_ID,DIAGNOSIS_CATEGORY);
```

```
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`New_diagnosis`('16','Throatinfection');
```

To create new bills

```
DELIMITER $$
CREATE PROCEDURE `Newbill_insert`(IN BILL_ID varchar(11),
IN  BILL_AMOUNT decimal(9,6),
IN CREATE_DATE date,
IN BILL_DUE date
)
BEGIN
INSERT INTO bill(bill_no,amount,bill_date,due_date)
values(BILL_ID,BILL_AMOUNT,CREATE_DATE,BILL_DUE);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Newbill_insert`('1',' 555','2017-04-03','2017-05-03');
CALL `student_clinic_db_final`.`Newbill_insert`('2',' 550','2017-04-03','2017-05-04');
CALL `student_clinic_db_final`.`Newbill_insert`('3',' 111','2017-03-03','2017-04-05');
CALL `student_clinic_db_final`.`Newbill_insert`('4',' 220','2017-05-03','2017-06-03');
```

To create prescription

```
DELIMITER $$
CREATE PROCEDURE `Prescription_insert`(IN PRESCRIP_ID varchar(11),
IN  MED_QTY int(11)
)
BEGIN
INSERT INTO prescription(prescription_id,medicine_quantity) values(PRESCRIP_ID,MED_QTY);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Prescription_insert`('14','50');
CALL `student_clinic_db_final`.`Prescription_insert`('15','75');
CALL `student_clinic_db_final`.`Prescription_insert`('16','95');
```

Insert into prescription medicine

```
DELIMITER $$
CREATE PROCEDURE `Prescription_med_insert`(IN PRESCRIP_ID varchar(11),
IN  MED_INVTRY_ID varchar(11))
BEGIN
INSERT INTO prescription_medicine(prescription_id,med_inventory_id)
values(PRESCRIP_ID,MED_INVTRY_ID);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Prescription_med_insert`('45','897');
CALL `student_clinic_db_final`.`Prescription_med_insert`('55','900');
CALL `student_clinic_db_final`.`Prescription_med_insert`('34','789');
```

To insert into payment table

```
DELIMITER $$
CREATE PROCEDURE `Payment_insert`(IN  TRANSCTION_NUM varchar(11),
IN  METHOD varchar(90),
IN  PAYSTATUS varchar(45),
IN  PAYDATE date
)
BEGIN
INSERT INTO Payment(pay_trans_num,pay_method,pay_status,pay_date)
values(TRANSCTION_NUM,METHOD,PAYSTATUS,PAYDATE);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Payment_insert`('107','SELF','PAID','2017-11-09');
CALL `student_clinic_db_final`.`Payment_insert`('108','INSURANCE','PAID','2017-01-12');
CALL `student_clinic_db_final`.`Payment_insert`('109','SELF','PENDING','2017-05-17');
CALL `student_clinic_db_final`.`Payment_insert`('110','INSURANCE','PENDING','2017-08-01');
```

Student insurance insert

```
DELIMITER $$
CREATE PROCEDURE `Studentinsurance_insert`(IN  STUD_ID varchar(7), IN  INSURNC_ID
varchar(90))
BEGIN
INSERT INTO student_insurance(student_id,insurance_id)
values(STUD_ID,INSURNC_ID);
END$$
DELIMITER ;
```

```
CALL `student_clinic_db_final`.`Studentinsurance_insert`('10','2');
CALL `student_clinic_db_final`.`Studentinsurance_insert`('55','2');
```

To insert billpayment

```
DELIMITER $$
CREATE PROCEDURE `BillPayment_insert`(IN BILL_ID varchar(11),
IN  TRANS_NUM varchar(11))
BEGIN
INSERT INTO bill_payment(bill_no,pay_trans_num)
values(BILL_ID,TRANS_NUM);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`BillPayment_insert`('1','106');
CALL `student_clinic_db_final`.`BillPayment_insert`('2','107');
CALL `student_clinic_db_final`.`BillPayment_insert`('3','108');
CALL `student_clinic_db_final`.`BillPayment_insert`('4','109');
```

Update Procedures:

Given student id and bill amount to be updated:

```
DELIMITER $$
CREATE PROCEDURE `Update_BillAmount`(IN STUD_ID varchar(12),
IN  AMOUNT_UPDATE decimal(9,6)
)
BEGIN
UPDATE bill set amount=AMOUNT_UPDATE where bill_no
in(SELECT bill_no from student_bill where student_id=STUD_ID);
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Update_BillAmount`('1','555');
```

Given student id and update the payment status:

```
DELIMITER $$
CREATE PROCEDURE `Update_PaymentStatus`(IN STUD_ID varchar(12),
IN  STATUS_UPDATE varchar(45)
)
BEGIN
```

```
UPDATE payment set pay_status=STATUS_UPDATE where pay_trans_num
in(SELECT pay_trans_num from bill_payment where bill_no
in(SELECT bill_no from student_bill where student_id=STUD_ID));
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Update_PaymentStatus`('1','Paid');
```

Updating insurance company id for a given student_id:

```
DELIMITER $$
CREATE PROCEDURE `Update_InsuranceCompany`(IN STUD_ID varchar(12),
IN  Company_UPDATE varchar(7))
BEGIN
UPDATE student_insurance set insurance_id=Company_UPDATE
where student_id=STUD_ID;
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Update_InsuranceCompany`('1','50');
```

Delete Procedure

To delete student record

```
DELIMITER $$
CREATE PROCEDURE `Del_Student`
(IN DEL_STUDENT_ID varchar(12))
BEGIN
delete from student where student_id= DEL_STUDENT_ID;
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Del_Student`('3');
```

To delete diagnosis record

```
DELIMITER $$
CREATE PROCEDURE `DEL_diagnosis_data`
(IN Del_DIAGNOSIS_ID varchar(12))
BEGIN
DELETE FROM diagnosis WHERE diagnosis_id = Del_DIAGNOSIS_ID;
```

```
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`DEL_diagnosis_data`('903');
```

To delete doctor data

```
SELECT * FROM student_clinic_db_final.doctor;
DELIMITER $$
CREATE PROCEDURE `Delete_Doctor`
(IN Del_Doc varchar(12))
BEGIN
DELETE FROM doctor WHERE doctor_id = Del_Doc;
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Delete_Doctor`('202');
```

To delete insurance company data

```
DELIMITER $$
CREATE PROCEDURE `Del_InsuranceCompany`
(IN DEL_COMPANY_ID varchar(12))
BEGIN
DELETE FROM insurance where insurance_id = DEL_COMPANY_ID;
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Del_InsuranceCompany`('5');
```

To delete medicine record

```
DELIMITER $$
CREATE PROCEDURE `Delete_medicine`(IN Del_Med varchar(12))
BEGIN
DELETE FROM medicine WHERE med_inventory_id = Del_Med;
END$$
DELIMITER ;

CALL `student_clinic_db_final`.`Delete_medicine`('321');
```

APPLICATION PROGRAMMING INTERFACE – STORED PROCEDURES

Create an application programming interface (API) using stored procedures that allows an EMR system developer to work with the database without having to write SQL statements

Ans: To demonstrate the API we have created stored procedures for following scenario's.

1. Select all the students having insurance

```
DELIMITER $$
CREATE PROCEDURE `student_having_insurance`()
BEGIN
select s.student_name, i.insurance_company
from insurance i
join student_insurance using(insurance_id)
join student s using (student_id);
END$$
DELIMITER;

CALL `student_clinic_db_final`.`student_having_insurance`();
```

student_name	insurance_company
Suyash Nande	General Insurance
Rahul	AIG
Neha	Aurora Boralis
John	Life Insure
Abhishek	ABC

2. Get all the visit granted by Dr. Rahul

```
DELIMITER $$
CREATE PROCEDURE `ALL_VISIT_FOR_DR_RAHUL`(IN DOC_NAME_INPUT
varchar(255))
BEGIN
select visit.visit_id, visit.visit_date, doctor.doctor_id
from visit
join doctor using(doctor_id)
join diagnosis using(diagnosis_id)
join prescription using(prescription_id)
where doctor.doc_name=DOC_NAME_INPUT;
```

```
END$$
DELIMITER ;

set @DOC_NAME_INPUT='Dr. Rahul';
CALL `student_clinic_db_final`.`ALL_VISIT_FOR_DR_RAHUL`(@DOC_NAME_INPUT);
```

visit_id	visit_date	doctor_id
1	2017-04-10	101
2	2017-04-11	101

3. Get the bill details and payment number of Suyash Nande

```
DELIMITER $$
CREATE PROCEDURE `BILL_DETAILS_SUYASH`(IN STU_NAME varchar(255))
BEGIN
select student.student_name, student.student_id, bill.bill_no, bill.bill_date,
payment.pay_trans_num, payment.pay_date
from bill
join bill_payment using (bill_no)
join payment using (pay_trans_num)
join student_bill using (bill_no)
join student using (student_id)
where student.student_name=STU_NAME;
END$$
DELIMITER ;

set @STU_NAME='Suyash Nande';
CALL `student_clinic_db_final`.`BILL_DETAILS_SUYASH`(@STU_NAME);
```

student_name	student_id	bill_no	bill_date	pay_trans_num	pay_date
Suyash Nande	1	5	2016-10-12	101	2017-02-19

4. Get the names and contact of all doctors who have visited at least 1 student

```
DELIMITER $$
CREATE PROCEDURE `DOC_VISIT_HISTORY`(IN NO_OF_VISITS int)
BEGIN
select doctor.doc_name, doctor.doc_contact_no
from doctor
where doctor_id in (select doctor_id
```

```
from visit
join visit_history using (visit_id)
group by visit.doctor_id
having max(visit_history.student_id)>=NO_OF_VISITS);
END$$
DELIMITER ;

set @NO_OF_VISITS=2;
CALL `student_clinic_db_final`.`DOC_VISIT_HISTORY`(@NO_OF_VISITS);
```

doc_name	doc_contact_no
Dr. Bomma	+19234768753
Dr. Singh	+18603768753
Dr. Vikas	+19803234753

5. Find the names of the students and their address who have visited to more than one doctor.

```
DELIMITER $$
CREATE PROCEDURE `STU_VISIT_HISTORY`
(IN NO_OF_VISITS int)
BEGIN
select s.student_name, s.address, count(v.doctor_id)
from student s, visit v, visit_history vh, doctor d
where v.visit_id = vh.visit_id
and vh.student_id = s.student_id
and v.doctor_id = d.doctor_id
group by s.student_name,s.address
having count(v.doctor_id) > NO_OF_VISITS;
END$$
DELIMITER ;

set @NO_OF_VISITS = 1;
CALL `student_clinic_db_final`.`STU_VISIT_HISTORY`(@NO_OF_VISITS);
```

student_name	address	count(v.doctor_id)
Suyash Nande	UT Drive, Charlotte, NC	2

6. Find the name of the doctors with their contact numbers whom has been visited by only student.

```
DELIMITER $$
CREATE PROCEDURE `ONE_STUDENT_DOC`(IN NO_OF_VISIT int)
BEGIN
select d.doc_name, count(v.doctor_id)
from doctor d, visit v
where d.doctor_id = v.doctor_id
group by doc_name,doc_contact_no
having count(v.doctor_id)=NO_OF_VISIT;
END$$
DELIMITER ;

SET @NO_OF_VISIT=1;
CALL `student_clinic_db_final`.`ONE_STUDENT_DOC`(@NO_OF_VISIT);
```

doc_name	count(v.doctor_id)
Dr. Bomma	1
Dr. Singh	1
Dr. Vikas	1

7. Find names, id's, record id and vaccine category for students who have been given vaccination of FLU and order by student name

```
DELIMITER $$
CREATE PROCEDURE `STU_WITH_VACC`(IN VACC_NAME varchar(255))
BEGIN
select student.student_name, student.student_id, i.record_id ,i.vaccine_category
from student
join immunization_record i using(student_id)
where i.vaccine_category = VACC_NAME
order by student_name;
END$$
DELIMITER ;

SET @VACC_NAME='FLU';
CALL `student_clinic_db_final`.`STU_WITH_VACC`(@VACC_NAME);
```

student_name	student_id	record_id	vaccine_category
Abhishek	10	103	Flu
Suyash Nande	1	101	Flu

8. Find number of visits for any student

```
DELIMITER $$
CREATE PROCEDURE `VISITS_OF_ANY_STUDENT`(IN STU_NAME
varchar(255))
BEGIN
select student.student_name, COUNT(visit_history.visit_id) AS NumofVisits
from student
join visit_history using(student_id)
where student_name = STU_NAME;
END$$
DELIMITER ;

SET @STU_NAME='Suyash Nande';
CALL `student_clinic_db_final`.`VISITS_OF_ANY_STUDENT`(@STU_NAME);
```

student_name	NumofVisits
Suyash Nande	2

9. Find the number of Visits on a particular day

```
DELIMITER $$
CREATE PROCEDURE `No_Of_Visit_On_Any_Date`(IN VISIT_DATE date, out
NUM_OF_VISITS int)
BEGIN
select COUNT(visit_id) AS NumofVisits into NUM_OF_VISITS
from visit where visit_date = VISIT_DATE;
END$$
DELIMITER ;

SET @VISIT_DATE = '2017-03-15';
CALL `student_clinic_db_final`.`No_Of_Visit_On_Any_Date`(@VISIT_DATE,
@NUM_OF_VISITS);
SELECT @NUM_OF_VISITS;
```

@NUM_OF_VISITS
5

10. Find the student name and payment status whose payment status is pending. Order by name.

```
DELIMITER $$
CREATE PROCEDURE `Payment_Status_Of_Student`(IN STATUS varchar(255))
BEGIN
select student.student_name , student.student_id, payment.pay_status
from student
join student_bill using (student_id)
join bill_payment using (bill_no)
join payment using ( pay_trans_num)
where pay_status = STATUS
order by student.student_name;
END$$
DELIMITER ;

SET @STATUS='Pending';
CALL `student_clinic_db_final`.`Payment_Status_Of_Student`(@STATUS);
```

student_name	student_id	pay_status
John	5	Pending
Neha	4	Pending
Rahul	3	Pending

11. Find out the department name from any complaint from the student

```
DROP PROCEDURE IF EXISTS dptname_forcomplaint;
DELIMITER $$
CREATE PROCEDURE `dptname_forcomplaint`(IN complaint varchar(55))
begin
select d.doc_name,d.doctor_id, a.dpt_name,a.dpt_id
from doctor d, affiliated_with a,visit v
where d.doctor_id = a.doctor_id
and v.doctor_id = a.doctor_id
and v.complaint= complaint;
END$$
```

```
DELIMITER ;

SET @Complaint='Hypertension';
CALL `student_clinic_db_final_final`.`dptname_forcomplaint`(@Complaint);
```

doc_name	doctor_id	dpt_name	dpt_id
Dr. Bomma	103	Physiotherapy	9003

12. Find out details of the doctor for any department

```
Drop procedure if exists `docname_fordept`;
Delimiter $$
CREATE procedure `docname_fordept`(IN department_name varchar(55))
begin
select d.doc_name, d.doctor_id, a.dpt_name
from doctor d, affiliated_with a
where d.doctor_id = a.doctor_id
and a.dpt_name like department_name;
END; $$
DELIMITER ;

set @department_name = 'General Medicine';
CALL `student_clinic_db_final_final`.`docname_fordept`(@department_name);
```

doc_name	doctor_id	dpt_name
Dr. Ryan	101	General Medicine
Dr. Khan	106	General Medicine
Dr. Preeti	107	General Medicine

Add tables and other features to enable audit trail so that every query or change of every record in the database is monitored and the entire history of the data in the database is captured. Basically, every time a record is accessed (queried, inserted, or changed), the user and time of access is recorded. Every time any field of a record is updated or deleted, the previous value of the record is saved.

Ans: We have created audit trial for following tables:

- visit table - Update, Delete and Insert operation.
- payment table - Update, Delete and Insert operation.
- appointment table - Update, Delete and Insert operation.

Justification of why audit trial is not needed for certain entity tables like Student, doctor, receptionist, medicine, department, privilege , user_role; and certain tables like bill_payment, student_bill that are used for are mapping the relationship for two tables and are not updated frequently.

Audit Trial for Visit table

- **Trigger for before update operation**

```
DROP TRIGGER IF EXISTS student_clinic_db_final.audit_visit_bu;
DELIMITER $$
create trigger audit_visit_bu BEFORE UPDATE on Visit
for each row
begin
insert into audit_trial_visit SELECT 'BEFORE UPDATE', NULL, NOW(),
current_user(), V.* from visit as V
where V.visit_id = old.visit_id;
end;$$
DELIMITER ;
```

- **Trigger for after update operation**

```
DROP TRIGGER IF EXISTS student_clinic_db_final.audit_visit_au;
DELIMITER $$
create trigger audit_visit_au AFTER UPDATE on Visit
for each row
begin
insert into audit_trial_visit SELECT 'AFTER UPDATE', NULL, NOW(), current_user(),
V.* from visit as V
```

```
where V.visit_id = new.visit_id;
end;$$
DELIMITER ;
```

- **Trigger for insert operation**

```
DROP TRIGGER IF EXISTS student_clinic_db_final.visit_after_insert
DELIMITER $$
create trigger visit_after_insert AFTER INSERT on Visit
for each row
Begin
insert into audit_trial_visit SELECT 'INSERT', NULL, NOW(), current_user(), V.* from
visit as V
where V.visit_id = new.visit_id;
End; $$
DELIMITER ;
```

- **Trigger for delete operation**

```
DROP TRIGGER IF EXISTS student_clinic_db_final.visit_before_delete
DELIMITER $$
create trigger visit_before_delete BEFORE DELETE on Visit
for each row
Begin
insert into audit_trial_visit SELECT 'DELETE', NULL, NOW(), current_user(), V.* from
visit as V
where V.visit_id = old.visit_id;
End; $$
DELIMITER ;
```

```
9  update visit set complaint='Chest Pain New' where visit_id=4;
10
11 insert into visit values(6, '2017-04-11', '14:10:00', 'test', 14, 104, 55);
12
13 delete from visit where visit_id=6;
14
15 SELECT * FROM `student_clinic_db`.`audit_trial_visit`;
16
```

100% 62:9

Result Grid | Filter Rows: Search | Edit: | Export/Import:

action	revision	dt_datetime	user_name	visit_id	visit_date	time	complaint	diagnosis_id	doctor_id	prescription_...
BEFORE UPDATE	5	2017-04-15 18:50:30	root@localhost	1	2017-03-10	09:10:00	ABC	11	101	12
AFTER UPDATE	6	2017-04-15 18:50:30	root@localhost	1	2017-03-10	09:10:00	ABC1	11	101	12
BEFORE UPDATE	7	2017-04-15 18:52:34	root@localhost	2	2017-03-11	10:00:00	Tharki	12	102	23
AFTER UPDATE	8	2017-04-15 18:52:34	root@localhost	2	2017-03-11	10:00:00	ABC1	12	102	23
INSERT	9	2017-04-15 19:58:54	root@localhost	6	2017-04-11	14:10:00	test	14	104	55
DELETE	10	2017-04-15 19:59:34	root@localhost	6	2017-04-11	14:10:00	test	14	104	55

Audit Trial for Payment table

- **Trigger for before update operation**

```
DROP TRIGGER IF EXISTS student_clinic_db_final.audit_payment_bu;
DELIMITER $$
create trigger audit_payment_bu BEFORE UPDATE on payment
for each row
begin
insert into audit_trial_payment SELECT 'BEFORE UPDATE', NULL, NOW(), current_user(),
P.* from payment as P
where P.pay_trans_num = old.pay_trans_num;
end;$$
DELIMITER ;
```

- **Trigger for after update operation**

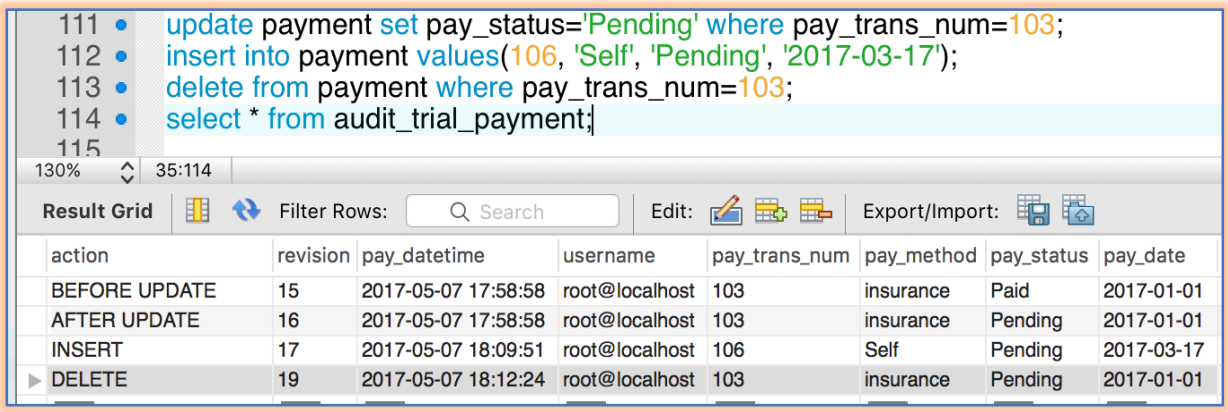
```
DROP TRIGGER IF EXISTS student_clinic_db_final.audit_payment_au;
DELIMITER $$
create trigger audit_payment_au AFTER UPDATE on payment
for each row
begin
insert into audit_trial_payment SELECT 'AFTER UPDATE', NULL, NOW(), current_user(),
P.* from payment as P
where P.pay_trans_num = new.pay_trans_num;
end;$$
DELIMITER ;
```

- **Trigger for insert operation**

```
DROP TRIGGER IF EXISTS student_clinic_db_final.audit_payment_after_insert;
DELIMITER $$
create trigger audit_payment_after_insert AFTER INSERT on payment
for each row
Begin
insert into audit_trial_payment SELECT 'INSERT', NULL, NOW(), current_user(), P.* from
payment as P
where P.pay_trans_num = new.pay_trans_num;
End; $$
DELIMITER ;
```

- **Trigger for delete operation**

```
DROP TRIGGER IF EXISTS student_clinic_db_final.audit_payment_after_delete;
DELIMITER $$
create trigger audit_payment_after_delete BEFORE DELETE on payment
for each row
Begin
insert into audit_trial_payment SELECT 'DELETE', NULL, NOW(), current_user(), P.* from
payment as P
where P.pay_trans_num = old.pay_trans_num;
End; $$
DELIMITER ;
```



```
111  update payment set pay_status='Pending' where pay_trans_num=103;
112  insert into payment values(106, 'Self', 'Pending', '2017-03-17');
113  delete from payment where pay_trans_num=103;
114  select * from audit_trial_payment;
115
```

130% 35:114

Result Grid | Filter Rows: Search | Edit: | Export/Import:

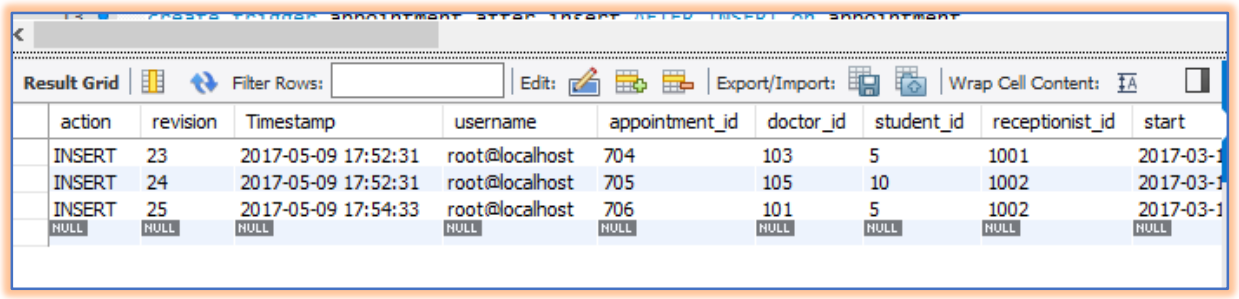
action	revision	pay_datetime	username	pay_trans_num	pay_method	pay_status	pay_date
BEFORE UPDATE	15	2017-05-07 17:58:58	root@localhost	103	insurance	Paid	2017-01-01
AFTER UPDATE	16	2017-05-07 17:58:58	root@localhost	103	insurance	Pending	2017-01-01
INSERT	17	2017-05-07 18:09:51	root@localhost	106	Self	Pending	2017-03-17
DELETE	19	2017-05-07 18:12:24	root@localhost	103	insurance	Pending	2017-01-01

Audit trail for appointment

1) **Audit trial for insert into appointment :**

```
DROP TRIGGER IF EXISTS student_clinic_database.appointment_after_insert
DELIMITER $$
create trigger appointment_after_insert AFTER INSERT on appointment
for each row
Begin
insert into audit_trial_appointment SELECT 'INSERT', NULL, NOW(), current_user(), a.*
from
appointment as a
where a.appointment_id = new.appointment_id;
End; $$
DELIMITER ;
```

```
select * from audit_trial_appointment;
```



Result Grid | Filter Rows: | Edit: | Export/Import: | Wrap Cell Content:

action	revision	Timestamp	username	appointment_id	doctor_id	student_id	receptionist_id	start
INSERT	23	2017-05-09 17:52:31	root@localhost	704	103	5	1001	2017-03-1
INSERT	24	2017-05-09 17:52:31	root@localhost	705	105	10	1002	2017-03-1
INSERT	25	2017-05-09 17:54:33	root@localhost	706	101	5	1002	2017-03-1
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

2) Trigger for before Update appointment

```
DROP TRIGGER IF EXISTS student_clinic_database.appointment_before_update;
DELIMITER $$
create trigger appointment_before_update BEFORE UPDATE on appointment
for each row
begin
insert into appointment SELECT 'BEFORE UPDATE', NULL, NOW(),
current_user(), a.* from appointment as a
where a.appointment_id = old.appointment_id;
end;$$
DELIMITER ;
```

3) **Trigger for after Update appointment**

```
DROP TRIGGER IF EXISTS student_clinic_database.appointment_after_update;
DELIMITER $$
create trigger appointment_after_update AFTER UPDATE on appointment
for each row
begin
insert into appointment SELECT 'AFTER UPDATE', NULL, NOW(),
current_user(), a.* from appointment as a
where a.appointment_id = new.appointment_id;
end;$$
DELIMITER ;
```

Add user authentication so that only authorized users can access the database.

Ans: The primary aim of the access control mechanism in MySQL is to authenticate a user based on his username, host and password and to associate the user with privileges on different databases and tables such as Select, Update, Insert, etc.

Following are the salient features:

- Users are assigned to certain roles which are based on their job assignment and access privileges.
- These relationships are many-to-many i.e. the user may have several roles and each role can be assigned to several users.
- Similarly, an action may be assigned to several roles while a role may have several actions.
- It provides administrator with the capability to place constraints on role authorization, role activation and operation execution.

user_role table

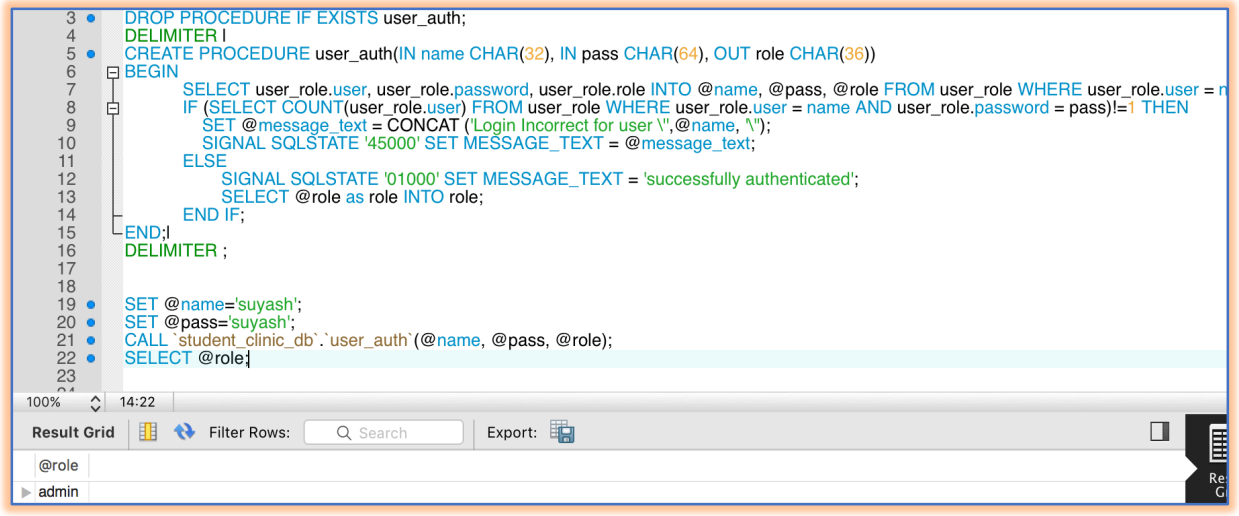
```
CREATE TABLE `user_role` (
  `user` varchar(45) NOT NULL,
  `password` varchar(45) NOT NULL,
  `role` varchar(45) NOT NULL,
  `host` varchar(45) NOT NULL,
  PRIMARY KEY (`user`,`role`,`host`)
) ;
```

Procedure for User Authentication

```
DROP PROCEDURE IF EXISTS user_auth;
DELIMITER |
CREATE PROCEDURE user_auth
(IN name CHAR(32), IN pass CHAR(64), OUT role CHAR(36))
BEGIN
SELECT user_role.user, user_role.password, user_role.role INTO @name, @pass, @role
FROM user_role WHERE user_role.user = name;
 IF (SELECT COUNT(user_role.user) FROM user_role WHERE user_role.user = name AND
user_role.password = pass)!=1 THEN
SET @message_text = CONCAT ('Login Incorrect for user \'',@name, '\'');
SIGNAL SQLSTATE '45000' SET MESSAGE_TEXT = @message_text;
ELSE
SIGNAL SQLSTATE '01000' SET MESSAGE_TEXT = 'successfully authenticated';
SELECT @role as role INTO role;
```

```
END IF;
END;|
DELIMITER ;

SET @name='suyash';
SET @pass='suyash';
CALL `student_clinic_db_final`.`user_auth`(@name, @pass, @role);
SELECT @role;
```

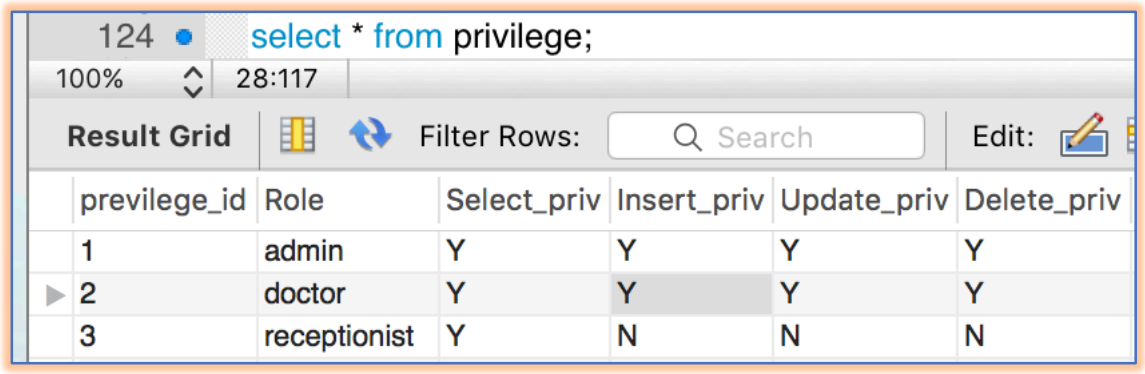


User Authentication Implementation

For every procedure call we ensured only authorized user can execute the procedure. Henceforth, we have created role based privilege table.

privilege table – all the privileges are stored with privilege_id and role as as Primary Key

```
CREATE TABLE `privilege` (
  `previlege_id` int(11) NOT NULL,
  `Role` varchar(45) NOT NULL,
  `Select_priv` enum('N','Y') NOT NULL,
  `Insert_priv` enum('N','Y') NOT NULL,
  `Update_priv` enum('N','Y') NOT NULL,
  `Delete_priv` enum('N','Y') NOT NULL,
PRIMARY KEY (`previlege_id`,`Role`)
) ;
```



```
124  select * from privilege;
```

100% 28:117

Result Grid | Filter Rows: Search | Edit:

previlege_id	Role	Select_priv	Insert_priv	Update_priv	Delete_priv
1	admin	Y	Y	Y	Y
2	doctor	Y	Y	Y	Y
3	receptionist	Y	N	N	N

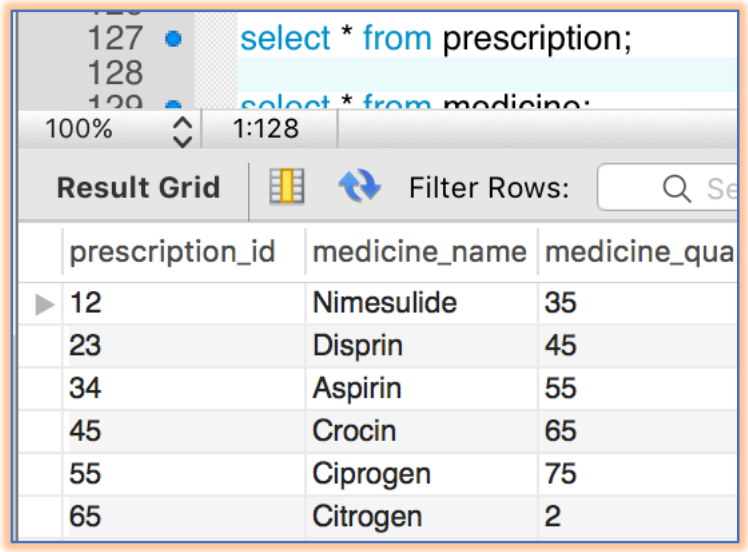
Role based Scenario

When a student consults doctor, then doctor can create, delete and update his prescription. Here only doctor should have privilege to create, delete and update the prescription of the student. Other role such as receptionist can only view the prescription.

Prescription created by the doctor

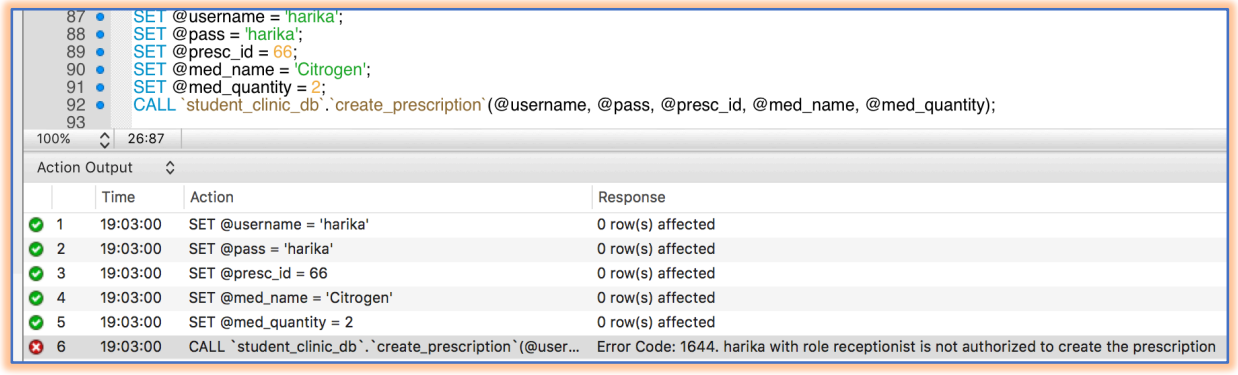
```
DROP PROCEDURE IF EXISTS create_prescription;
DELIMITER $$
CREATE PROCEDURE `create_prescription`
(IN username varchar(255), IN pass varchar(255),IN  presc_id int, IN med_name varchar(255),
IN med_quantity int)
BEGIN
CALL user_auth(username, pass, @role);
IF(@role like 'doctor')
THEN
IF ((select Insert_priv from privilege where Role like 'doctor') like 'Y')
THEN
insert into prescription values(presc_id, med_name, med_quantity);
ELSE
SET @message_text = CONCAT(username, ' donot have insert privilege');
SIGNAL SQLSTATE '45000' SET MESSAGE_TEXT = @message_text;
END IF;
ELSE
SET @message_text = CONCAT(username, ' with role ', @role, ' is not authorized to create the
prescription');
SIGNAL SQLSTATE '45000' SET MESSAGE_TEXT = @message_text;
END IF;
END$$
DELIMITER ;
```

```
SET @username = 'abhishek';
SET @pass = 'abhishek';
SET @presc_id = 65;
SET @med_name = 'Citrogen';
SET @med_quantity = 2;
CALL `student_clinic_db_final`.`create_prescription`(@username, @pass, @presc_id,
@med_name, @med_quantity);
```



prescription_id	medicine_name	medicine_qua
12	Nimesulide	35
23	Disprin	45
34	Aspirin	55
45	Crocin	65
55	Ciprogen	75
65	Citrogen	2

Now receptionist cannot create a prescription

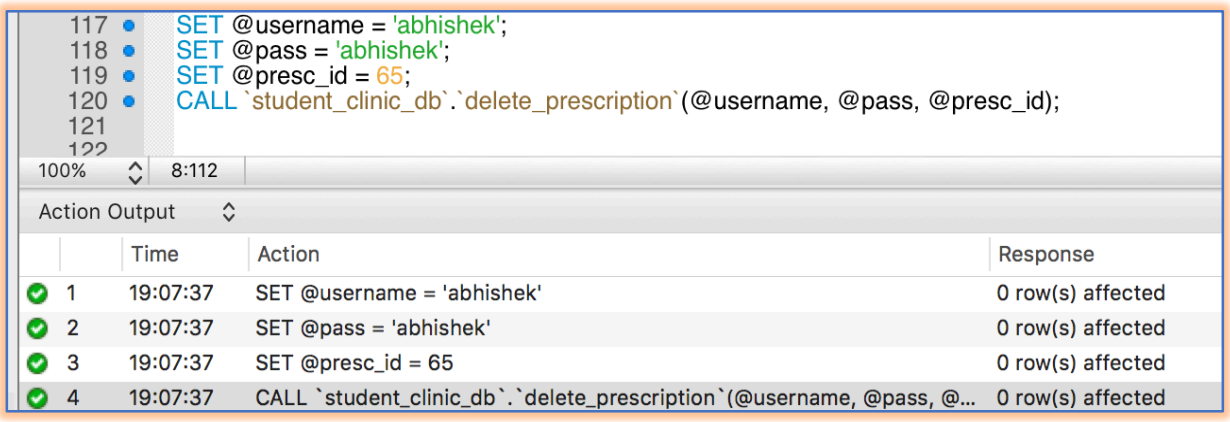


	Time	Action	Response
1	19:03:00	SET @username = 'harika'	0 row(s) affected
2	19:03:00	SET @pass = 'harika'	0 row(s) affected
3	19:03:00	SET @presc_id = 66	0 row(s) affected
4	19:03:00	SET @med_name = 'Citrogen'	0 row(s) affected
5	19:03:00	SET @med_quantity = 2	0 row(s) affected
6	19:03:00	CALL `student_clinic_db`.`create_prescription`(@user...	Error Code: 1644. harika with role receptionist is not authorized to create the prescription

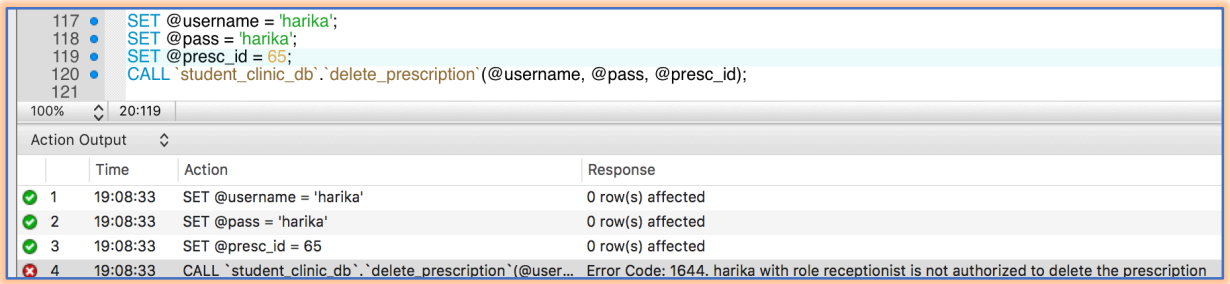
Prescription deleted by the doctor

```
DROP PROCEDURE IF EXISTS delete_prescription;
DELIMITER $$
CREATE PROCEDURE `delete_prescription`
```

```
(IN username varchar(255), IN pass varchar(255),IN  presc_id int)
BEGIN
CALL user_auth(username, pass, @role);
IF(@role like 'doctor')
THEN
IF ((select Delete_priv from privilege where Role like 'doctor') like 'Y')
THEN
delete from prescription where prescription_id=presc_id;
ELSE
SET @message_text = CONCAT(username, ' donot have delete privilege');
SIGNAL SQLSTATE '45000' SET MESSAGE_TEXT = @message_text;
END IF;
ELSE
SET @message_text = CONCAT(username, ' with role ', @role, ' is not authorized to delete the
prescription');
SIGNAL SQLSTATE '45000' SET MESSAGE_TEXT = @message_text;
END IF;
END$$
DELIMITER ;
```



Now receptionist cannot delete a prescription



- **Add indexes and views so that frequently used queries and changes to the database are most efficient.**

Ans: Views are stored queries that when invoked produce a result set. A **view** acts as a virtual table.

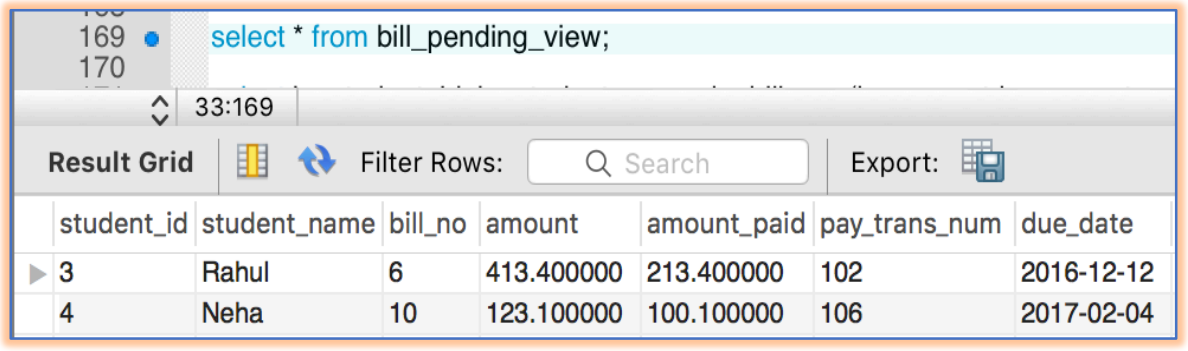
We have created views for following scenarios.

Scenario I

When we need to find out the students with pending bills.

Solution: To find out the students who didn't paid the full amount i.e. whose bills are pending; we need to join **five tables** Student, Bill, Payment, bill_payment and student_bill. Henceforth we created a view wherein we joined all these five tables.

```
create or replace view bill_pending_view as
select student.student_id, student.student_name, student_bill.bill_no, bill.amount,
bill.amount_paid, payment.pay_trans_num, bill.due_date
from bill
join bill_payment using (bill_no)
join payment using (pay_trans_num)
join student_bill using (bill_no)
join student using (student_id)
where (bill.amount_paid<bill.amount);
```



student_id	student_name	bill_no	amount	amount_paid	pay_trans_num	due_date
3	Rahul	6	413.400000	213.400000	102	2016-12-12
4	Neha	10	123.100000	100.100000	106	2017-02-04

Now we'll use the above created view to calculate the remaining amount to be paid by the student with his due date.

```
select bv.student_id, bv.student_name, bv.bill_no, (bv.amount-bv.amount_paid) as
amount_remaining, bv.due_date
from bill_pending_view bv
join payment p using(pay_trans_num)
```

```
where bv.student_name = 'Rahul';
```

```
171  select bv.student_id, bv.student_name, bv.bill_no, (bv.amount-bv.amount_paid) as amount_remaining, bv.due_date
172  from bill_pending_view bv
173  join payment p using(pay_trans_num)
174  where bv.student_name = 'Rahul';
175
```

36:173

Result Grid | Filter Rows: Search | Export:

student_id	student_name	bill_no	amount_remaining	due_date
3	Rahul	6	200.000000	2016-12-12

Scenario II

When we need to find out the students with paid bills.

Solution: To find out the students who already paid the full amount i.e. whose bills are paid; we need to join **five tables** Student, Bill, Payment, bill_payment and student_bill. Henceforth we created a view wherein we joined all these five tables.

```
create or replace view bill_paid_view as
select student.student_id, student.student_name, student_bill.bill_no, bill.amount,
bill.amount_paid, payment.pay_trans_num
from bill
join bill_payment using (bill_no)
join payment using (pay_trans_num)
join student_bill using (bill_no)
join student using (student_id)
where (bill.amount_paid = bill.amount);
```

```
186  select * from bill_paid_view;
```

32:183

Result Grid | Filter Rows: Search | Export:

student_id	student_name	bill_no	amount	amount_paid	pay_trans_num
1	Suyash Nande	5	566.500000	566.500000	101
5	John	11	22.200000	22.200000	104
10	Abhishek	35	399.300000	399.300000	105

Scenario III

When we need to find out total number of medicines prescribed to a student 'Suyash Nande'

Solution: To find total number of medicines prescribed to a student we need to join **five tables** Student, Visit, visit_history, Doctor and Prescription. Henceforth we created a view which consists of results by joining all these tables for any student.

```
create or replace view Medicine_For_Student as
select s.student_id,s.student_name,v.visit_id,d.doc_name, p.medicine_name AS
Prescribed_Medicine
from student s
join visit_history using(student_id)
join visit v using (visit_id)
join doctor d using(doctor_id)
join prescription p using(prescription_id)
where s.student_name = 'Suyash Nande';
```

```
200 • select * from Medicine_For_Student;
201
    36:200
Result Grid | Filter Rows: Search | Expo
```

student_id	student_name	visit_id	doc_name	Prescribed_Medici...
1	Suyash Nande	1	Dr. Rahul	Nimesulide
1	Suyash Nande	3	Dr. Rahul	Aspirin

Now we'll use above created view to calculate the total number of medicines prescribed for that student.

```
202 • select student_id, student_name, count(*) as Total_Num_Medicines from Medicine_For_Student;
    1:199
Result Grid | Filter Rows: Search | Export:
```

student_id	student_name	Total_Num_Medicines
1	Suyash Nande	2

Scenario IV

When we need to find out maximum visit for any department.

Solution: To find maximum number of visit for any department we need to join two tables affiliated_with and visit and the result set should contain information about all the department with their visit count.

```
create or replace view dept_with_max_visit as
select a.dpt_id, a.dpt_name, count(a.dpt_name) as max_visit
from affiliated_with a
join visit v using(doctor_id)
group by a.dpt_id, a.dpt_name
HAVING max(v.doctor_id);
```

```
217  select * from dept_with_max_visit;
     1:208
Result Grid   Filter Rows:   Sear
```

dpt_id	dpt_name	max_visit
9001	General Medicine	2
9002	Psychiatry	1
9004	Orthopedics	1
9005	Cardiology	1

Now among these we need to select the department with the maximum visit count.

```
select dpt_id, dpt_name, max(max_visit) from dept_with_max_visit;
```

```
219  select  dpt_id, dpt_name, max(max_visit) from dept_with_max_visit;
     1:218
Result Grid   Filter Rows:   Search   Export:
```

dpt_id	dpt_name	max(max_visit)
9001	General Medicine	2

Indexes

Index is a data structure that improves the speed of search operation in a table. It can be created using one or more columns. Indexes are also type of tables, which keep primary key or index field and a pointer to each record into the actual table.

Users cannot see the indexes, they are just to speed up queries and will be used by database search engine to locate records very fast.

We have created indexes for every tables based on primary key and foreign key.

Scenario I: Index for visit table

```
225  show index from visit;
```

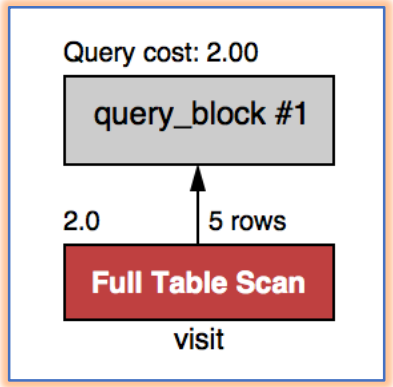
100% 23:225

Result Grid | Filter Rows: Search | Export:

Table	Non_unique	Key_name	Seq_in_index	Column_name	Collation	Cardinality	Sub_part	Packed	Null	Index_type
visit	0	PRIMARY	1	visit_id	A	5	NULL	NULL		BTREE
visit	1	diagnosis_id	1	diagnosis_id	A	5	NULL	NULL	YES	BTREE
visit	1	doctor_id	1	doctor_id	A	4	NULL	NULL	YES	BTREE
visit	1	prescription_id	1	prescription_id	A	5	NULL	NULL	YES	BTREE
visit	1	visit_ibfk_4_idx	1	appointment_id	A	1	NULL	NULL	YES	BTREE

In the above visit table, **visit_id is the primary key** and **diagnosis_id, doctor_id, prescription_id and appointment_id are the foreign keys.** Hence we have created indexes for all the keys.

Find the visit details of a student based on non-index field visit_date.
Ans: select * from visit where visit_date='2017-03-16';



```
234 • select * from visit where visit_date='2017-03-16';
```

100% 1:233

Query Statistics

Timing (as measured at client side):
Execution time: 0:00:0.00040317

Timing (as measured by the server):
Execution time: 0:00:0.00024748
Table lock wait time: 0:00:0.00011400

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 1
Rows examined: 5

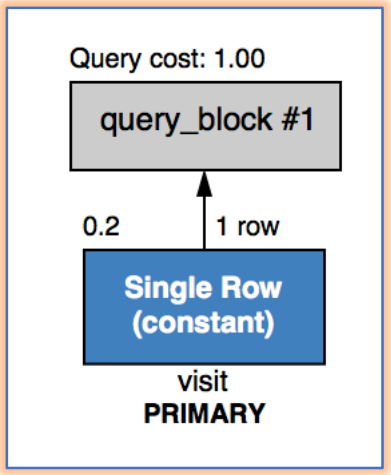
Joins per Type:
Full table scans (Select_scan): 1
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

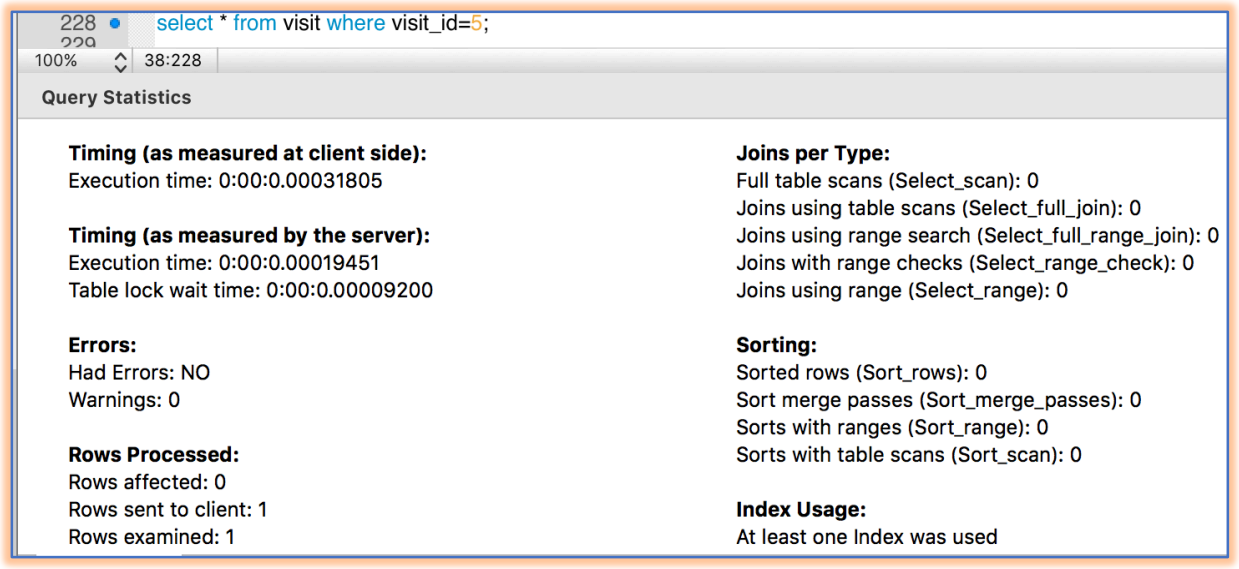
Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
No Index used

In the above query, full table is scanned as no index were used. Therefore, the **query cost is 2.0**. And hence execution time is **0.00040317 seconds**.

Now on using the index field *visit_id* we will perform the same operation.
Ans: select * from visit where visit_id=5;





In the above query index was used, **query cost is 1.0** and time taken to execute the query was **0.00031805 seconds.**

Hence, by using the index the same result set takes **0.00008512 seconds** less time to execute so it is faster to search via an index field.

Experience

- Creating audit trial was not an easy task, as it involves triggers that run before and after each query execution for that table, so we need to carefully examine the tuple data before inserting and updating it.

- Implementing user authentication and role based access was a challenging task. We have implemented the same into the stored procedures so that every time we call these procedures it will first check the authorization of the user and if the user is authorized then it will again check for that user privilege to execute the SQL statements written in the stored procedures.

- Merging the relations was made easy since foreign keys existed that referenced the various tables that were merged.

- The SQL statement became complex and more error-prone as the number of relations to be merged increased.

Individual Contribution

Harika Katragadda	• Insert API • Delete API • Update API • Indexes • ER Diagram
Abhishek Deshpande	• Views • UML Diagram • Audit Trial • Triggers
Suyash Nande	• APIs for scenario's • Triggers • User Authentication • Role Based Access Control • Views