

# Information Systems and Databases

## Report 2nd Project Assignment

### **Health care center database**

15/11/2017

1st Semester – 2017/2018

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## I. Create the database

```
create table Patient
(patient_number varchar(255),
patient_name  varchar(255),
birthday date,
address  varchar(255),
primary key(patient_number));

create table Doctor
(patient_number  varchar(255),
doctor_id  varchar(255),
primary key(doctor_id),
foreign key (patient_number) references Patient(patient_number));

create table Device
(serialnum varchar(255),
manufacturer varchar(255),
model varchar(255),
primary key(serialnum, manufacturer));

create table Sensor
(serialnum varchar(255),
manufacturer varchar(255),
units varchar(255),
primary key(serialnum, manufacturer),
foreign key(serialnum, manufacturer) references Device(serialnum, manufacturer));

create table Reading
(serialnum varchar(255),
manufacturer varchar(255),
read_datetime timestamp,
value float(10,2),
primary key(serialnum, manufacturer, read_datetime),
foreign key(serialnum, manufacturer) references Sensor(serialnum, manufacturer));

create table Period
(start_date timestamp,
end_date timestamp,
primary key(start_date, end_date));

create table Wears
(start_date timestamp,
end_date timestamp,
patient_number varchar(255),
serialnum varchar(255),
manufacturer varchar(255),
primary key(start_date, end_date, patient_number),
foreign key(start_date, end_date) references Period(start_date, end_date),
foreign key(patient_number) references Patient(patient_number),
foreign key(serialnum, manufacturer) references Device(serialnum, manufacturer));

create table Request
(request_number int(10) UNSIGNED,
patient_number varchar(255),
doctor_id varchar(255),
request_date date,
primary key(request_number),
foreign key(patient_number) references Patient(patient_number),
foreign key(doctor_id) references Doctor(doctor_id));

create table Study
(request_number int(10) UNSIGNED,
description varchar(255),
study_date date,
```

```

        doctor_id varchar(255),
        manufacturer varchar(255),
        serialnum varchar(255),
        primary key(request_number, description),
        foreign key(request_number) references Request(request_number),
        foreign key(doctor_id) references Doctor(doctor_id),
        foreign key(serialnum, manufacturer) references Device(serialnum, manufacturer));

create table Series
(series_id int(10) UNSIGNED,
series_name varchar(255),
base_url varchar(255),
request_number int(10) UNSIGNED,
description varchar(255),
primary key(series_id),
foreign key(request_number, description) references Study(request_number, description));

create table Element
(series_id int(10) UNSIGNED,
elem_index int(10) UNSIGNED,
primary key(series_id, elem_index),
foreign key(series_id) references Series(series_id));

create table Region
(series_id int(10) UNSIGNED,
elem_index int(10) UNSIGNED,
x1 float(4,3),
y1 float(4,3),
x2 float(4,3),
y2 float(4,3),
primary key(series_id, elem_index, x1, y1, x2, y2),
foreign key(series_id, elem_index) Element(series_id, elem_index));

```

## II. Querys

**1. Query to retrieve the name(s) of patient(s) with the highest number of readings of units of “LDL cholesterol in mg/dL” above 200 in the past 90 days**

```

select patient_name
from Patient natural join Reading natural join Sensor natural join Wears
where value > 200 and units like 'LDL cholesterol in mg/dL' and
      TIMESTAMPDIFF(day, read_datetime, CURRENT_TIMESTAMP()) <= 90
group by patient_name
having count(value) >= all (select count(value)
                           from Patient natural join Reading natural join Sensor natural join Wears
                           where value > 200 and units like 'LDL cholesterol in mg/dL' and
                           TIMESTAMPDIFF(day, read_datetime, CURRENT_TIMESTAMP()) <= 90
                           group by patient_name);

```

## 2. Query to retrieve the name(s) of patient(s) who have been subject of studies with all devices of manufacturer "Medtronic" in the past calendar year

```
select patient_name
from Patient as p
where not exists (select serialnum
                  from Device as d
                  where manufacturer like 'Medtronic'
                  and serialnum not in (select serialnum
                                       from Study as s, Request as r, Patient as p2
                                       where s.request_number = r.request_number and
                                             r.patient_number = p2.patient_number and
                                             YEAR(s.study_date) = YEAR(CURRENT_DATE()) - 1 and
                                             p.patient_name = p2.patient_name));
```

## III. Triggers

In this version of *mysql*, it's necessary to create two triggers: one for inserting data into Study table and another one for update it.

### 1. Trigger to ensure that a doctor who prescribes an exam may not perform that same exam

```
delimiter $$
create trigger prevent_insert before insert on Study
for each row
begin
    if exists(select *
              from Request
              where request_number = new.request_number and doctor_id = new.doctor_id) then
        call doctor_who_prescribes_an_exam_cannot_perform_the_same_exam();
    end if;
end$$
delimiter ;

delimiter $$
create trigger prevent_update before update on Study
for each row
begin
    if exists(select *
              from Request
              where request_number = new.request_number and doctor_id = new.doctor_id) then
        call doctor_who_prescribes_an_exam_cannot_perform_the_same_exam();
    end if;
end$$
delimiter ;
```

### 2. Trigger to prevent someone from trying to associate a device to a patient in overlapping periods. Additionally, when this event occurs, a text message "Overlapping periods" will be thrown

```
delimiter $$
create trigger prevent_device_association_insert before insert on Wears
for each row
begin
    if exists(select *
              from Wears
              where serialnum = new.serialnum and manufacturer = new.manufacturer and patient_number = new.patient_number and
                    (((TIMESTAMPDIFF(second, start_date, new.end_date) >= 0) and (TIMESTAMPDIFF(second, new.end_date, end_date) >= 0)) or
                     ((TIMESTAMPDIFF(second, start_date, new.start_date) >= 0) and (TIMESTAMPDIFF(second, new.start_date, end_date) >= 0)) or
                     ((TIMESTAMPDIFF(second, new.start_date, start_date) >= 0) and (TIMESTAMPDIFF(second, end_date, new.end_date) >= 0)))) then

        signal sqlstate '45000' set message_text = 'Overlapping Periods';
    end if;
end$$
delimiter ;

delimiter $$
```

```

create trigger prevent_device_association_insert before update on Wears
for each row
begin
    if exists(select *
              from Wears
              where serialnum = new.serialnum and manufacturer = new.manufacturer and patient_number = new.patient_number and
                (((TIMESTAMPDIFF(second, start_date, new.end_date) >= 0) and (TIMESTAMPDIFF(second, new.end_date, end_date) >= 0)) or
                 ((TIMESTAMPDIFF(second, start_date, new.start_date) >= 0) and (TIMESTAMPDIFF(second, new.start_date, end_date) >= 0)) or
                 ((TIMESTAMPDIFF(second, new.start_date, start_date) >= 0) and (TIMESTAMPDIFF(second, end_date, new.end_date) >= 0)))) then

        signal sqlstate '45000' set message_text = 'Overlapping Periods';

    end if;
end$$
delimiter ;

```

These triggers prevent someone from inserting or updating a row in table Wears, if that insert or update include associating the same device to different patients in overlapping periods. However, if the same patient needs to extend or change the period of wearing a certain device, it's possible to do it, if there isn't another patient that is wearing that same device in an overlapping period.

## IV. Function

```

delimiter $$
create function region_overlaps_element(series_id_A int(10), elem_index_A int(10), x1_B float(4,3), y1_B float(4,3), x2_B float(4,3), y2_B float(4,3))
returns int
begin
    declare overlaps int;
    select count(r.elem_index) into overlaps
    from region as r
    where r.series_id = series_id_A and r.elem_index = elem_index_A and
          ((r.x1 < x2_B) and (r.x2 > x1_B) and (r.y1 < y2_B) and (r.y2 > y1_B));
    if overlaps > 0 then
        set overlaps = 1;
    end if;
    return overlaps;
end$$
delimiter ;

```

This function *region\_overlaps\_element()* checks if a given Region B (x1\_B, y1\_B, x2\_B, y2\_B) overlaps with any region of Element A (series\_id\_A, elem\_index\_A). If overlaps return 1 (means TRUE). Otherwise returns 0 (means FALSE).

**NOTE:** it's assumed that: x1 < x2 and y1 < y2.

## V. Populate tables

```

insert into Patient values ('P-1', 'John Smith', '1990-07-01', 'London');
insert into Patient values ('P-2', 'Roger Smith', '1987-05-05', 'Liverpool');
insert into Patient values ('P-3', 'James Bond', '1975-08-30', 'Bristol');
insert into Patient values ('P-4', 'Kelly Fernandez', '1985-10-06', 'London');
insert into Patient values ('P-5', 'Liz Wang', '1987-12-25', 'Birmingham');
insert into Patient values ('P-6', 'Richard Gun', '1965-11-15', 'Manchester');
insert into Patient values ('P-7', 'Gisele Joly', '1950-02-07', 'Manchester');
insert into Patient values ('P-8', 'Isaac Newton', '1966-04-09', 'Sheffield');
insert into Patient values ('P-9', 'Lillian Holmes', '1955-06-20', 'Liverpool');
insert into Patient values ('P-10', 'Wellington Ramirez', '1959-09-14', 'London');

insert into Doctor values ('P-1', 'D-101');
insert into Doctor values ('P-2', 'D-102');
insert into Doctor values ('P-3', 'D-103');
insert into Doctor values ('P-4', 'D-104');
insert into Doctor values ('P-5', 'D-105');
insert into Doctor values ('P-6', 'D-106');
insert into Doctor values ('P-7', 'D-107');

```

```

insert into Doctor values ('P-8', 'D-108');
insert into Doctor values ('P-9', 'D-109');
insert into Doctor values ('P-10', 'D-110');

insert into Device values ('S1', 'Siemens', 's6373');
insert into Device values ('B1', 'Bosch', 'b7566');
insert into Device values ('A1', 'Airsense', 'a9800');
insert into Device values ('A2', 'Airsense', 'a7658');
insert into Device values ('A3', 'Airsense', 'a3333');
insert into Device values ('A4', 'Airsense', 'a3333');
insert into Device values ('A5', 'Airsense', 'a9800');
insert into Device values ('S2', 'Siemens', 's3421');
insert into Device values ('B2', 'Bosch', 'b8765');
insert into Device values ('T1', 'Thermotec', 't2990');
insert into Device values ('T2', 'Thermotec', 't2990');
insert into Device values ('H1', 'Honeywell', 'h6776');
insert into Device values ('H2', 'Honeywell', 'h4444');
insert into Device values ('E1', 'Envitec', 'e5876');
insert into Device values ('E2', 'Envitec', 'e5876');
insert into Device values ('M1', 'Medtronic', 'm7891');
insert into Device values ('M2', 'Medtronic', 'm4536');
insert into Device values ('M3', 'Medtronic', 'm6543');
insert into Device values ('M4', 'Medtronic', 'm9023');
insert into Device values ('M5', 'Medtronic', 'm7123');
insert into Device values ('S3', 'Siemens', 's4040');
insert into Device values ('S4', 'Siemens', 's3131');
insert into Device values ('S5', 'Siemens', 's1111');
insert into Device values ('B3', 'Bosch', 'b4589');
insert into Device values ('B4', 'Bosch', 'b3232');
insert into Device values ('B5', 'Bosch', 'b4455');
insert into Device values ('I1', 'Iberdata', 'i3030');
insert into Device values ('I2', 'Iberdata', 'i9009');
insert into Device values ('I3', 'Iberdata', 'i7050');
insert into Device values ('I4', 'Iberdata', 'i3553');
insert into Device values ('I5', 'Iberdata', 'i7005');
insert into Device values ('I6', 'Iberdata', 'i6531');

insert into Sensor values ('S1', 'Siemens', 'LDL cholesterol in mg/dL');
insert into Sensor values ('B1', 'Bosch', 'Creatinine in mg/L');
insert into Sensor values ('A1', 'Airsense', 'HDL cholesterol in mg/dL');
insert into Sensor values ('A2', 'Airsense', 'Hemoglobin in g/dL');
insert into Sensor values ('A3', 'Airsense', 'Creatinine in mg/L');
insert into Sensor values ('A4', 'Airsense', 'Creatinine in mg/L');
insert into Sensor values ('A5', 'Airsense', 'Hemoglobin in g/dL');
insert into Sensor values ('S2', 'Siemens', 'HDL cholesterol in mg/dL');
insert into Sensor values ('B2', 'Bosch', 'LDL cholesterol in mg/dL');
insert into Sensor values ('T1', 'Thermotec', 'Temperature in °C');
insert into Sensor values ('T2', 'Thermotec', 'Temperature in °C');
insert into Sensor values ('H1', 'Honeywell', 'Glucose level in mmol/L');
insert into Sensor values ('H2', 'Honeywell', 'Glucose level in mmol/L');
insert into Sensor values ('E1', 'Envitec', 'Hemoglobin in g/dL');
insert into Sensor values ('E2', 'Envitec', 'Creatinine in mg/L');

insert into Reading values ('S1', 'Siemens', '2017-10-30 18:20:00', 217);
insert into Reading values ('S1', 'Siemens', '2017-10-30 18:21:00', 225);
insert into Reading values ('S1', 'Siemens', '2017-10-15 13:12:11', 220);
insert into Reading values ('S1', 'Siemens', '2017-10-17 20:08:21', 201);
insert into Reading values ('B1', 'Bosch', '2017-10-15 10:17:55', 10.1);
insert into Reading values ('A1', 'Airsense', '2017-07-31 15:25:45', 77);
insert into Reading values ('A1', 'Airsense', '2017-08-7 08:54:07', 100);
insert into Reading values ('A2', 'Airsense', '2017-10-31 09:57:35', 12.8);
insert into Reading values ('A2', 'Airsense', '2017-03-17 11:47:59', 15.7);
insert into Reading values ('A3', 'Airsense', '2016-12-25 20:20:20', 8.2);
insert into Reading values ('A4', 'Airsense', '2017-01-20 23:17:05', 11.8);
insert into Reading values ('A5', 'Airsense', '2017-03-29 21:40:47', 17.2);
insert into Reading values ('S2', 'Siemens', '2017-01-29 19:20:27', 117);
insert into Reading values ('B2', 'Bosch', '2017-10-14 10:39:06', 224);

```

```

insert into Reading values ('T1', 'Thermotec', '2017-10-28 07:44:21', 35);
insert into Reading values ('T2', 'Thermotec', '2016-04-06 09:45:17', 36.5);
insert into Reading values ('T2', 'Thermotec', '2016-07-16 11:12:12', 34.7);
insert into Reading values ('H1', 'Honeywell', '2017-10-31 12:55:59', 5.9);
insert into Reading values ('H2', 'Honeywell', '2016-04-17 14:32:58', 7.5);
insert into Reading values ('E1', 'Envitec', '2016-01-30 16:27:44', 17.9);
insert into Reading values ('E2', 'Envitec', '2017-05-29 19:42:28', 12.2);

insert into Period values ('2017-04-01 10:00:01', '2017-10-31 17:18:19');
insert into Period values ('2017-01-17 08:11:17', '2017-10-25 19:00:91');
insert into Period values ('2016-01-02 10:08:00', '2030-12-31 00:00:00');
insert into Period values ('2017-03-04 12:34:55', '2030-12-31 00:00:00');
insert into Period values ('2015-05-08 22:30:05', '2030-12-31 00:00:00');
insert into Period values ('2016-02-26 13:08:45', '2030-12-31 00:00:00');
insert into Period values ('2016-07-31 15:03:41', '2017-09-17 13:00:07');
insert into Period values ('2016-08-26 21:00:23', '2017-02-23 17:55:42');
insert into Period values ('2017-04-06 12:07:44', '2030-12-31 00:00:00');
insert into Period values ('2016-01-12 00:00:00', '2017-11-02 07:15:18');
insert into Period values ('2017-05-10 11:12:15', '2030-12-31 00:00:00');
insert into Period values ('2016-04-2 08:11:17', '2016-12-15 00:00:00');
insert into Period values ('2016-03-20 20:17:25', '2017-01-01 10:00:10');
insert into Period values ('2016-01-07 12:00:15', '2016-04-28 17:17:17');
insert into Period values ('2016-01-02 09:30:27', '2016-01-07 18:20:24');
insert into Period values ('2017-02-01 10:10:10', '2020-02-01 00:00:00');
insert into Period values ('2017-11-01 00:00:00', '2017-11-05 00:00:00');

insert into Wears values ('2017-04-01 10:00:01', '2017-10-31 17:18:19', 'P-1', 'S1', 'Siemens');
insert into Wears values ('2017-01-17 08:11:17', '2017-10-25 19:00:21', 'P-2', 'B1', 'Bosch');
insert into Wears values ('2016-01-02 10:08:00', '2030-12-31 00:00:00', 'P-3', 'A1', 'AirSense');
insert into Wears values ('2017-03-04 12:34:55', '2030-12-31 00:00:00', 'P-4', 'A2', 'AirSense');
insert into Wears values ('2015-05-08 22:30:05', '2030-12-31 00:00:00', 'P-5', 'A3', 'AirSense');
insert into Wears values ('2016-02-26 13:08:45', '2030-12-31 00:00:00', 'P-6', 'A4', 'AirSense');
insert into Wears values ('2016-07-31 15:03:41', '2017-09-17 13:00:07', 'P-7', 'A5', 'AirSense');
insert into Wears values ('2016-08-26 21:00:23', '2017-02-23 17:55:42', 'P-8', 'S2', 'Siemens');
insert into Wears values ('2017-04-06 12:07:44', '2030-12-31 00:00:00', 'P-9', 'B2', 'Bosch');
insert into Wears values ('2016-01-12 00:00:00', '2017-11-02 07:15:18', 'P-10', 'T1', 'Thermotec');
insert into Wears values ('2017-05-10 11:12:15', '2030-12-31 00:00:00', 'P-8', 'H1', 'Honeywell');
insert into Wears values ('2016-04-02 08:11:10', '2016-12-15 00:01:10', 'P-2', 'T2', 'Thermotec');
insert into Wears values ('2016-03-20 20:17:25', '2017-01-01 10:00:10', 'P-1', 'H2', 'Honeywell');
insert into Wears values ('2016-01-07 12:00:15', '2016-04-28 17:17:17', 'P-7', 'E1', 'Envitec');
insert into Wears values ('2016-01-02 09:30:27', '2016-01-07 18:20:24', 'P-10', 'E2', 'Envitec');

insert into Request values (1, 'P-1', 'D-101', '2016-02-07');
insert into Request values (2, 'P-2', 'D-102', '2017-07-17');
insert into Request values (3, 'P-3', 'D-103', '2016-05-15');
insert into Request values (4, 'P-4', 'D-104', '2017-08-31');
insert into Request values (5, 'P-5', 'D-105', '2016-10-16');
insert into Request values (6, 'P-6', 'D-106', '2016-09-21');
insert into Request values (7, 'P-7', 'D-107', '2017-04-19');
insert into Request values (8, 'P-8', 'D-108', '2017-01-21');
insert into Request values (9, 'P-9', 'D-109', '2016-12-16');
insert into Request values (10, 'P-10', 'D-110', '2017-06-25');
insert into Request values (11, 'P-5', 'D-105', '2017-05-09');
insert into Request values (12, 'P-7', 'D-107', '2017-10-24');
insert into Request values (13, 'P-8', 'D-108', '2016-07-05');
insert into Request values (14, 'P-2', 'D-102', '2016-04-02');
insert into Request values (15, 'P-1', 'D-101', '2016-10-09');
insert into Request values (16, 'P-3', 'D-103', '2017-09-06');
insert into Request values (17, 'P-4', 'D-104', '2017-03-11');
insert into Request values (18, 'P-3', 'D-103', '2016-02-10');
insert into Request values (19, 'P-3', 'D-103', '2016-04-03');
insert into Request values (20, 'P-3', 'D-103', '2016-07-20');
insert into Request values (21, 'P-3', 'D-103', '2016-09-07');

insert into Study values (1, 'X-ray both feet', '2016-03-05', 'D-102', 'Medtronic', 'M1');
insert into Study values (2, 'Ecography both feet', '2017-08-30', 'D-101', 'Medtronic', 'M2');
insert into Study values (3, 'Endoscopy esophagus', '2016-06-02', 'D-105', 'Medtronic', 'M3');

```

**insert into Study values** (4, 'Endoscopy stomach', '2017-10-07', 'D-103', 'Medtronic', 'M4');  
**insert into Study values** (5, 'Echocardiography', '2016-10-31', 'D-104', 'Medtronic', 'M5');  
**insert into Study values** (6, 'Mammography', '2016-03-05', 'D-107', 'Iberdata', 'I6');  
**insert into Study values** (7, 'Colonoscopy', '2017-05-12', 'D-110', 'Siemens', 'S3');  
**insert into Study values** (8, 'Magnetic Resonance both shoulders', '2017-02-25', 'D-101', 'Siemens', 'S4');  
**insert into Study values** (9, 'Magnetic Resonance both knees', '2017-01-08', 'D-108', 'Siemens', 'S5');  
**insert into Study values** (10, 'Electrocardiogram', '2017-07-27', 'D-109', 'Bosch', 'B3');  
**insert into Study values** (11, 'Electrocardiogram', '2017-10-08', 'D-106', 'Bosch', 'B4');  
**insert into Study values** (12, 'Prostate Specific Antigen (PSA test)', '2017-10-31', 'D-102', 'Bosch', 'B5');  
**insert into Study values** (13, 'Mammography', '2017-07-27', 'D-107', 'Iberdata', 'I1');  
**insert into Study values** (14, 'Colonoscopy', '2017-05-09', 'D-105', 'Iberdata', 'I2');  
**insert into Study values** (15, 'Echocardiography', '2017-10-29', 'D-108', 'Iberdata', 'I3');  
**insert into Study values** (16, 'X-ray chest', '2017-10-01', 'D-102', 'Iberdata', 'I4');  
**insert into Study values** (17, 'X-ray both elbows', '2017-05-27', 'D-101', 'Iberdata', 'I5');  
**insert into Study values** (18, 'X-ray right foot', '2016-03-25', 'D-104', 'Medtronic', 'M1');  
**insert into Study values** (19, 'Ecography left foot', '2016-08-31', 'D-109', 'Medtronic', 'M2');  
**insert into Study values** (20, 'Endoscopy stomach', '2016-10-10', 'D-110', 'Medtronic', 'M4');  
**insert into Study values** (21, 'Echocardiography', '2016-10-17', 'D-105', 'Medtronic', 'M5');

**insert into Series values** (1, 'X-ray right foot', 'http://www.healthcarecentre/11/', 1, 'X-ray both feet');  
**insert into Series values** (2, 'X-ray left foot', 'http://www.healthcarecentre/21/', 1, 'X-ray both feet');  
**insert into Series values** (3, 'Ecography right foot', 'http://www.healthcarecentre/32/', 2, 'Ecography both feet');  
**insert into Series values** (4, 'Ecography left foot', 'http://www.healthcarecentre/42/', 2, 'Ecography both feet');  
**insert into Series values** (5, 'Endoscopy esophagus', 'http://www.healthcarecentre/53/', 3, 'Endoscopy esophagus');  
**insert into Series values** (6, 'Endoscopy stomach', 'http://www.healthcarecentre/64/', 4, 'Endoscopy stomach');  
**insert into Series values** (7, 'Echocardiography', 'http://www.healthcarecentre/75/', 5, 'Echocardiography');  
**insert into Series values** (8, 'Mammography', 'http://www.healthcarecentre/86/', 6, 'Mammography');  
**insert into Series values** (9, 'Colonoscopy', 'http://www.healthcarecentre/97/', 7, 'Colonoscopy');  
**insert into Series values** (10, 'Magnetic Resonance right shoulder', 'http://www.healthcarecentre/108/', 8, 'Magnetic Resonance both shoulders');  
**insert into Series values** (11, 'Magnetic Resonance left shoulder', 'http://www.healthcarecentre/118/', 8, 'Magnetic Resonance both shoulders');  
**insert into Series values** (12, 'Magnetic Resonance right knee', 'http://www.healthcarecentre/129/', 9, 'Magnetic Resonance both shoulders');  
**insert into Series values** (13, 'Magnetic Resonance left knee', 'http://www.healthcarecentre/139/', 9, 'Magnetic Resonance both shoulders');  
**insert into Series values** (14, 'Electrocardiogram', 'http://www.healthcarecentre/1410/', 10, 'Electrocardiogram');  
**insert into Series values** (15, 'Electrocardiogram', 'http://www.healthcarecentre/1511/', 11, 'Electrocardiogram');  
**insert into Series values** (16, 'Prostate Specific Antigen (PSA test)', 'http://www.healthcarecentre/1612/', 12, 'Prostate Specific Antigen (PSA test)');  
**insert into Series values** (17, 'Mammography', 'http://www.healthcarecentre/1713/', 13, 'Mammography');  
**insert into Series values** (18, 'Colonoscopy', 'http://www.healthcarecentre/1814/', 14, 'Colonoscopy');  
**insert into Series values** (19, 'Echocardiography', 'http://www.healthcarecentre/1915/', 15, 'Echocardiography');  
**insert into Series values** (20, 'X-ray chest', 'http://www.healthcarecentre/2016/', 16, 'X-ray chest');  
**insert into Series values** (21, 'X-ray right elbow', 'http://www.healthcarecentre/2117/', 17, 'X-ray both elbows');  
**insert into Series values** (22, 'X-ray left elbow', 'http://www.healthcarecentre/2217/', 17, 'X-ray both elbows');  
**insert into Series values** (23, 'X-ray right foot', 'http://www.healthcarecentre/2318/', 18, 'X-ray right foot');  
**insert into Series values** (24, 'Ecography left foot', 'http://www.healthcarecentre/2419/', 19, 'Ecography left foot');  
**insert into Series values** (25, 'Endoscopy stomach', 'http://www.healthcarecentre/2520/', 20, 'Endoscopy stomach');  
**insert into Series values** (26, 'Echocardiography', 'http://www.healthcarecentre/2621/', 21, 'Echocardiography');

**insert into Element values** (1, 1);  
**insert into Element values** (1, 2);  
**insert into Element values** (1, 3);  
**insert into Element values** (2, 1);  
**insert into Element values** (2, 2);  
**insert into Element values** (3, 1);  
**insert into Element values** (3, 2);  
**insert into Element values** (3, 3);  
**insert into Element values** (3, 4);  
**insert into Element values** (4, 1);  
**insert into Element values** (4, 2);  
**insert into Element values** (5, 1);  
**insert into Element values** (5, 2);  
**insert into Element values** (6, 1);  
**insert into Element values** (6, 2);  
**insert into Element values** (7, 1);



```

insert into Element values (7, 2);
insert into Element values (8, 1);
insert into Element values (8, 2);
insert into Element values (8, 3);
insert into Element values (8, 4);
insert into Element values (9, 1);
insert into Element values (9, 2);
insert into Element values (10, 1);
insert into Element values (10, 2);
insert into Element values (11, 1);
insert into Element values (11, 2);
insert into Element values (12, 1);
insert into Element values (12, 2);
insert into Element values (13, 1);
insert into Element values (13, 2);
insert into Element values (14, 1);
insert into Element values (14, 2);
insert into Element values (15, 1);
insert into Element values (15, 2);
insert into Element values (16, 1);
insert into Element values (16, 2);
insert into Element values (17, 1);
insert into Element values (17, 2);
insert into Element values (18, 1);
insert into Element values (18, 2);
insert into Element values (19, 1);
insert into Element values (19, 2);
insert into Element values (20, 1);
insert into Element values (20, 2);
insert into Element values (21, 1);
insert into Element values (21, 2);
insert into Element values (22, 1);
insert into Element values (22, 2);
insert into Element values (22, 3);
insert into Element values (22, 4);

```

```

insert into Region values (1, 1, 0.107, 0.638, 0.180, 0.762);
insert into Region values (1, 2, 0.230, 0.567, 0.443, 0.899);
insert into Region values (1, 3, 0.432, 0.565, 0.118, 0.779);
insert into Region values (2, 1, 0.508, 0.234, 0.734, 0.923);
insert into Region values (2, 1, 0.100, 0.100, 0.230, 0.230);
insert into Region values (2, 2, 0.214, 0.657, 0.978, 0.999);
insert into Region values (3, 1, 0.115, 0.376, 0.647, 0.762);
insert into Region values (3, 2, 0.534, 0.980, 0.234, 0.762);
insert into Region values (3, 3, 0.675, 0.192, 0.567, 0.762);
insert into Region values (3, 4, 0.453, 0.876, 0.290, 0.834);
insert into Region values (4, 1, 0.489, 0.789, 0.117, 0.878);
insert into Region values (4, 2, 0.222, 0.333, 0.444, 0.555);
insert into Region values (5, 1, 0.654, 0.218, 0.905, 0.675);
insert into Region values (5, 2, 0.232, 0.798, 0.190, 0.458);
insert into Region values (6, 1, 0.616, 0.717, 0.818, 0.919);
insert into Region values (6, 2, 0.111, 0.999, 0.222, 0.777);
insert into Region values (7, 1, 0.668, 0.669, 0.888, 0.889);
insert into Region values (7, 2, 0.558, 0.475, 0.222, 0.332);
insert into Region values (8, 1, 0.142, 0.173, 0.194, 0.289);
insert into Region values (8, 2, 0.765, 0.975, 0.333, 0.777);
insert into Region values (8, 3, 0.211, 0.991, 0.224, 0.664);
insert into Region values (8, 4, 0.168, 0.845, 0.333, 0.456);
insert into Region values (9, 1, 0.121, 0.343, 0.565, 0.787);
insert into Region values (9, 2, 0.099, 0.677, 0.345, 0.899);
insert into Region values (10, 1, 0.321, 0.654, 0.765, 0.987);
insert into Region values (10, 2, 0.545, 0.878, 0.688, 0.727);
insert into Region values (11, 1, 0.646, 0.789, 0.889, 0.989);
insert into Region values (11, 2, 0.109, 0.234, 0.565, 0.898);
insert into Region values (12, 1, 0.212, 0.245, 0.656, 0.787);
insert into Region values (12, 2, 0.893, 0.909, 0.345, 0.897);
insert into Region values (13, 1, 0.666, 0.999, 0.222, 0.666);

```

```

insert into Region values (13, 2, 0.878, 0.989, 0.356, 0.676);
insert into Region values (14, 1, 0.111, 0.225, 0.348, 0.987);
insert into Region values (14, 2, 0.590, 0.334, 0.212, 0.455);
insert into Region values (15, 1, 0.690, 0.990, 0.213, 0.676);
insert into Region values (15, 2, 0.276, 0.387, 0.432, 0.878);
insert into Region values (16, 1, 0.175, 0.345, 0.478, 0.889);
insert into Region values (16, 2, 0.289, 0.367, 0.878, 0.995);
insert into Region values (17, 1, 0.567, 0.890, 0.345, 0.789);
insert into Region values (17, 2, 0.465, 0.443, 0.556, 0.954);
insert into Region values (18, 1, 0.586, 0.669, 0.665, 0.753);
insert into Region values (18, 2, 0.123, 0.456, 0.789, 0.890);
insert into Region values (19, 1, 0.643, 0.717, 0.542, 0.999);
insert into Region values (19, 2, 0.545, 0.878, 0.688, 0.727);
insert into Region values (20, 1, 0.534, 0.796, 0.968, 0.998);
insert into Region values (20, 2, 0.321, 0.543, 0.765, 0.987);
insert into Region values (21, 1, 0.199, 0.299, 0.399, 0.599);
insert into Region values (21, 2, 0.209, 0.309, 0.409, 0.509);
insert into Region values (22, 1, 0.534, 0.756, 0.867, 0.957);
insert into Region values (22, 2, 0.476, 0.874, 0.565, 0.878);
insert into Region values (22, 3, 0.223, 0.345, 0.678, 0.967);
insert into Region values (22, 4, 0.234, 0.678, 0.456, 0.789);

```

## VI. Expected Results

- Figure 1 shows the result of the first query, which are the patients with the highest number of readings of 'LDL cholesterol in mg/dL' above 200 in the past 90 days:

```

mysql> select patient_name
-> from Patient natural join Reading natural join Sensor natural join Wears
-> where value > 200 and units like 'LDL cholesterol in mg/dL' and
->       TIMESTAMPDIFF(day, read_datetime, CURRENT_TIMESTAMP()) <= 90
-> group by patient_name
-> having count(value) >= all(select count(value)
->                             from Patient natural join Reading natural join Sensor natural join Wears
->                             where value > 200 and units like 'LDL cholesterol in mg/dL' and
->                             TIMESTAMPDIFF(day, read_datetime, CURRENT_TIMESTAMP()) <= 90
->                             group by patient_name);
+-----+
| patient_name |
+-----+
| John Smith   |
+-----+
1 row in set (0.00 sec)

```

Figure 1 – Result of the first query

- Figure 2 shows the result of the second query, which are the patients who have been subject of studies with all devices of manufacturer 'Medtronic':

```

mysql> select patient_name
-> from Patient as p
-> where not exists(select serialnum
->                  from Device as d
->                  where manufacturer like 'Medtronic'
->                  and serialnum not in (select serialnum
->                                         from Study as s, Request as r, Patient as p2
->                                         where s.request_number = r.request_number and
->                                         r.patient_number = p2.patient_number and
->                                         YEAR(s.study_date) = YEAR(CURRENT_DATE()) - 1 and
->                                         p.patient_name = p2.patient_name));
+-----+
| patient_name |
+-----+
| James Bond   |
+-----+
1 row in set (0.01 sec)

```

Figure 2 - Result of the second query

- Figures 3.1 and 3.2 show examples of the implementation of trigger 1, one for inserting a new record (prevent\_insert) and another one for updating an existing row (prevent\_update), in the table Study, respectively:

```
mysql> insert into Request values (22, 'P-1', 'D-101', '2017-05-07');
Query OK, 1 row affected (0.00 sec)

mysql> insert into Study values (22, 'X-ray right foot', '2017-07-02', 'D-101','Medtronic', 'M1');
ERROR 1305 (42000): PROCEDURE healthcarecentre.doctor_who_prescribes_an_exam_cannot_perform_the_same_exam does not exist
```

Figure 4.1 - Trigger 1 (prevent\_insert) example for trying to insert a record in Study table that has the same doctor that requested the exam

```
mysql> update Study set doctor_id = 'D-101' where request_number = 1;
ERROR 1305 (42000): PROCEDURE healthcarecentre.doctor_who_prescribes_an_exam_cannot_perform_the_same_exam does not exist
```

Figure 3.2 - Trigger 1 (prevent\_update) example for updating an existing row, trying to change the doctor of a study to the same doctor that made the request

- Figures 4.1, 4.2, 4.3 and 4.4 show examples of the implementation of trigger 2, two (4.1 and 4.4) for inserting a new record (prevent\_device\_association\_insert) and another two (4.2 and 4.3) for updating an existing row (prevent\_device\_association\_update) in the table Wears, respectively:

```
mysql> insert into Period values ('2017-02-01 10:10:10', '2020-02-01 00:00:00');
Query OK, 1 row affected (0.00 sec)

mysql> insert into Period values ('2016-01-01 10:10:10', '2017-01-01 00:00:00');
Query OK, 1 row affected (0.00 sec)

mysql> insert into Wears values ('2017-02-01 10:10:10', '2020-02-01 00:00:00', 'P-1', 'A1', 'AirSense');
ERROR 1644 (45000): Overlapping Periods
mysql> insert into Wears values ('2017-02-01 10:10:10', '2020-02-01 00:00:00', 'P-1', 'A2', 'AirSense');
ERROR 1644 (45000): Overlapping Periods
mysql> insert into Wears values ('2017-02-01 10:10:10', '2020-02-01 00:00:00', 'P-1', 'A5', 'AirSense');
ERROR 1644 (45000): Overlapping Periods
mysql> insert into Wears values ('2016-01-01 10:10:10', '2017-01-01 00:00:00', 'P-1', 'E2', 'Envitec');
ERROR 1644 (45000): Overlapping Periods
```

Figure 4.1 - Trigger 2 (prevent\_device\_association\_insert) example for trying to insert records that associates the same device, in overlapping periods, for two different patients, in Wears table

```
mysql> update Wears
-> set serialnum = 'S1', manufacturer = 'Siemens'
-> where start_date = '2016-07-31 15:03:41' and end_date = '2017-09-17 13:00:07' and patient_number = 'P-7';
ERROR 1644 (45000): Overlapping Periods
mysql> update Wears
-> set start_date = '2017-04-06 12:07:44', end_date = '2030-12-31 00:00:00', serialnum = 'B2', manufacturer = 'Bosch'
-> where start_date = '2016-01-02 09:30:27' and end_date = '2016-01-07 18:20:24' and patient_number = 'P-10';
ERROR 1644 (45000): Overlapping Periods
```

Figure 4.2 - Trigger 2 (prevent\_device\_association\_update) example for updating an existing row, trying to associate a device to different patients, in overlapping periods

```
mysql> insert into Period values ('2016-07-31 15:03:41', '2018-01-01 00:00:00');
Query OK, 1 row affected (0.00 sec)

mysql> update Wears
-> set start_date = '2016-07-31 15:03:41', end_date = '2018-01-01 00:00:00'
-> where patient_number = 'P-7' and start_date = '2016-07-31 15:03:41' and end_date = '2017-09-17 13:00:07';
Query OK, 1 row affected (0.01 sec)
Rows matched: 1 Changed: 1 Warnings: 0
```

Figure 4.3 – Trigger 2 (prevent\_device\_association\_update) example for trying to update a record in table Wears the is an extension of a period while a patient is wearing a device

```
mysql> insert into Wears values ('2016-07-31 15:03:41', '2018-01-01 00:00:00', 'P-7', 'A5', 'AirSense');
Query OK, 1 row affected (0.00 sec)
```

Figure 4.4 – Trigger 2 (prevent\_device\_association\_insert) example for trying to insert a new record in table Wears that is an extension of a period while a patient is wearing a device

- Figure 5.1, 5.2 and 5.3 show examples of the implementation of function `region_overlaps_element()`:

```
mysql> select region_overlaps_element(1, 1, 0.120, 0.700, 0.170, 0.750);
+-----+
| region_overlaps_element(1, 1, 0.120, 0.700, 0.170, 0.750) |
+-----+
| 1 |
+-----+
1 row in set (0.00 sec)

mysql> select region_overlaps_element(1, 1, 0.100, 0.500, 0.200, 0.800);
+-----+
| region_overlaps_element(1, 1, 0.100, 0.500, 0.200, 0.800) |
+-----+
| 1 |
+-----+
1 row in set (0.00 sec)
```

Figure 5.1 - Region B overlaps with region of element A – returns 1, that means TRUE

```
mysql> select region_overlaps_element(1, 1, 0.190, 0.638, 0.300, 0.638);
+-----+
| region_overlaps_element(1, 1, 0.190, 0.638, 0.300, 0.638) |
+-----+
| 0 |
+-----+
1 row in set (0.00 sec)

mysql> select region_overlaps_element(1, 1, 0.300, 0.125, 0.755, 0.800);
+-----+
| region_overlaps_element(1, 1, 0.300, 0.125, 0.755, 0.800) |
+-----+
| 0 |
+-----+
1 row in set (0.00 sec)
```

Figure 5.2 – Region B don't overlap with region of element A – returns 0, that means FALSE

```
mysql> select region_overlaps_element(2, 1, 0.100, 0.100, 0.200, 0.200);
+-----+
| region_overlaps_element(2, 1, 0.100, 0.100, 0.200, 0.200) |
+-----+
| 1 |
+-----+
1 row in set (0.00 sec)

mysql> select region_overlaps_element(2, 1, 0.050, 0.050, 0.090, 0.090);
+-----+
| region_overlaps_element(2, 1, 0.050, 0.050, 0.090, 0.090) |
+-----+
| 0 |
+-----+
1 row in set (0.00 sec)
```

Figure 5.3 – In this case, element 1 from series\_id = 2, has two regions and in the first case the given region B overlaps with one of them and in the second case don't overlap with any of them