Electronic Health Record(EHR) system - Schema Design

Functional requirement

(1) Patient Information
Enquiries: Query the personal information for a specific patient.
Adding: New patient registration.

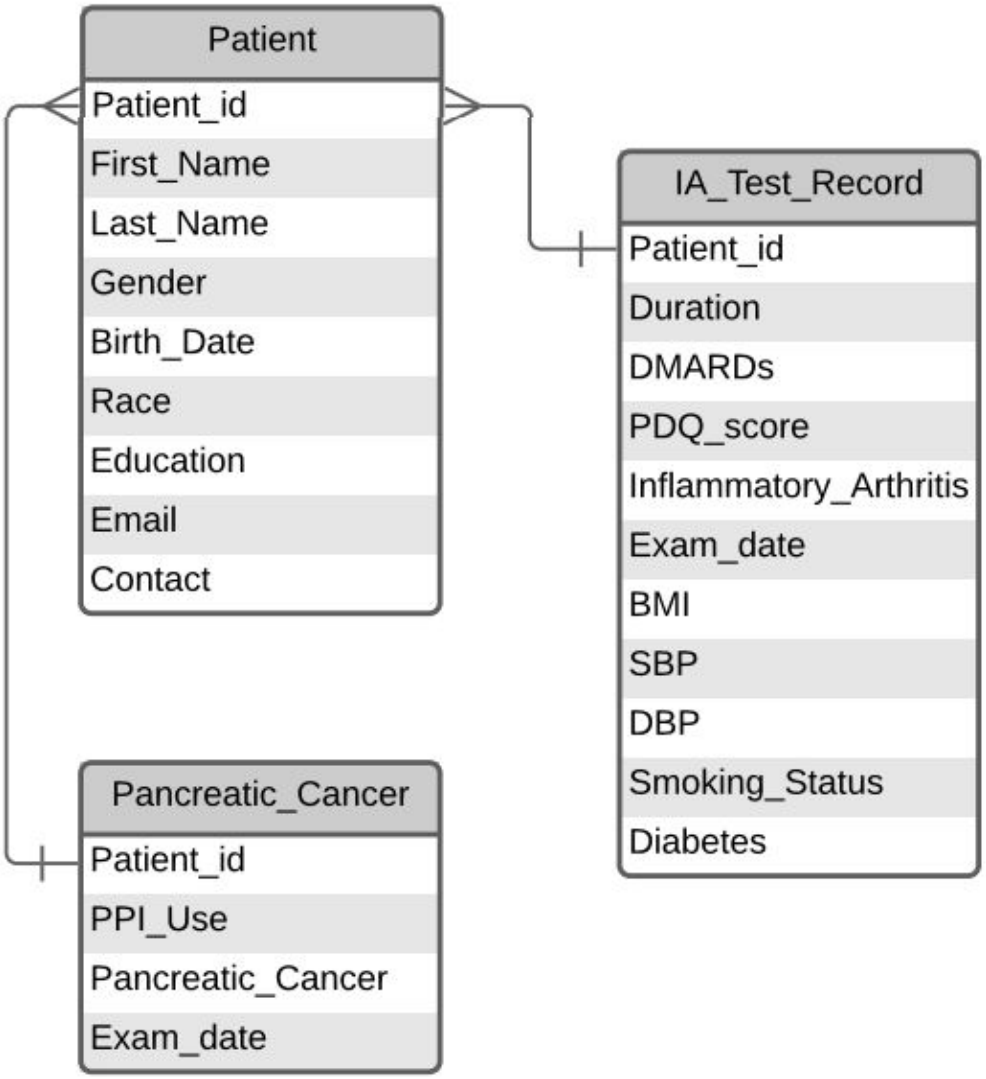
(2) Exam Information
Enquiries: Query the exam information for a specific patient.
Sorting: Sorting the exam information by date.
Adding: New exam information update.

Translation to Relational Schema

Patient(Patient_id, First_Name, Last_Name, Gender, Birth_Date, Race, Education, Email, Contact)
Pancreatic_Cancer(Patient_id, PPI_Use, Pancreatic_Cancer, Exam_date)
IA_Test_Record(Patient_id, Duration, DMARDs, PDQ_score, Inflammatory_Arthritis, Exam_date, BMI, SBP, DBP, Smoking_Status, Diabetes)

Functional dependencies

Optimize the translation relational schema, and determine the functional dependencies.



Pancreatic_Cancer(Patient_id, PPI_Use, Pancreatic_Cancer, Exam_date)
Patient_id is a Foreign key from relation Patient, attribute Patient_id.

IA_Test_Record(Patient_id, Duration, DMARDs, PDQ_score, Inflammatory_Arthritis, Exam_date, BMI, SBP, DBP, Smoking_Status, Diabetes)
Patient_id is a Foreign key from relation Patient, attribute Patient_id.

Database Structure

According to the overall database structure, the basic table structure of the Electronic Health Record (EHR) system is designed, and the corresponding target is defined as follows.

Table 1 Patient Information

Attribute	Type	Length	Can be null or not	explain

Patient_id	varchar	255	primary key	Identity number of patient
First_Name	varchar	255	not null	First Name
Last_Name	int	11	not null	Last Name
Gender	varchar	255	not null	Gender
Birth_Date	date	0	not null	Birth Date
Race	varchar	255	not null	Race
Education	varchar	255	not null	Education
Email	varchar	255	not null	Email of patient
Contact	varchar	255	not null	Contact of patient

Table 2 Pancreatic Cancer Information

Attribute	Type	Length	Can be null or not	explain
Patient_id	varchar	255	primary key	Identity number of patient
PPI_Use	varchar	255	not null	Proton Pump-Inhibitor Use(Yes=1, No=0)
Pancreatic_ Cancer	int	11	not null	Pancreatic Cancer status (Yes=1, No=0)
Exam_date	date	0	not null	Date of the exam

Table 3 Inflammatory Arthritis Test Record Information

Attribute	Type	Length	Can be null or not	explain
Patient_id	varchar	255	primary key	Identity number of patient
Duration	float	0	not null	Disease duration
DMARDs	int	11	not null	Disease modifying anti-rheumatic drugs
PDQ_score	int	11	not null	Pain DETECT Questionnaire score
Inflammatory_ Arthritis	int	11	not null	Inflammatory Arthritis Status (Yes=1, No=0)
Exam_date	date	0	not null	Date of the exam
BMI	float	0	not null	Body Mass Index
SBP	float	0	not null	Systolic Blood Pressure
DBP	float	0	not null	Diastolic Blood Pressure
Smoking_Status	int	11	not null	Smoking_Status(Yes=1, No=0)
Diabetes	int	11	not null	Diabetes Status(Yes=1, No=0)

Systems Implementation

1. Database Implementation

First create the database of the Electronic Health Record (EHR) system, and then create the six basic tables in the database structure. The specific SQL code is shown as follows:

(1) Create the database

```
CREATE DATABASE ehr;
```

(2) Create the table of Patient Information

```
DROP TABLE IF EXISTS `patient`;
CREATE TABLE `patient`  (
  `Patient_id` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'Identity number of patient',
  `First_Name` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'First Name',
  `Last_Name` int NOT NULL COMMENT 'Last Name',
  `Gender` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'Gender',
  `Birth_Date` date NOT NULL COMMENT 'Birth Date',
  `Race` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'Race',
  `Education` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'Education',
  `Email` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'Email of patient',
  `Contact` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'Contact of patient',
  PRIMARY KEY (`Patient_id`) USING BTREE
) ENGINE = InnoDB CHARACTER SET = utf8mb4 COLLATE = utf8mb4_0900_ai_ci ROW_FORMAT = Dynamic;
```

(3) Create the table of Pancreatic_Cancer information

```
DROP TABLE IF EXISTS `pancreatic_cancer`;
CREATE TABLE `pancreatic_cancer`  (
  `Patient_id` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'Identity number of patient',
  `PPI_Use` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT NULL COMMENT 'Proton Pump-Inhibitor Use(Yes=1, No=0)',
  `Pancreatic_Cancer` int NOT NULL COMMENT 'Pancreatic Cancer status\r\n(Yes=1, No=0)',
  `Exam_date` date NOT NULL COMMENT 'Date of the exam',
  PRIMARY KEY (`Patient_id`) USING BTREE,
  CONSTRAINT `Patient_id` FOREIGN KEY (`Patient_id`) REFERENCES `patient` (`Patient_id`) ON DELETE RESTRICT ON UPDATE RESTRICT
) ENGINE = InnoDB CHARACTER SET = utf8mb4 COLLATE = utf8mb4_0900_ai_ci ROW_FORMAT = Dynamic;
```

(4) Create the table of IA_Test_Record information

```
DROP TABLE IF EXISTS `ia_test_record`;
CREATE TABLE `ia_test_record`  (
```

```
  `Patient_id` varchar(255) CHARACTER SET utf8mb4 COLLATE utf8mb4_0900_ai_ci NOT
NULL COMMENT 'Identity number of patient',
  `Duration` float NOT NULL COMMENT 'Disease duration',
  `DMARDs` int NOT NULL COMMENT 'Disease modifying anti-rheumatic drugs',
  `PDQ_score` int NOT NULL COMMENT 'Pain DETECT Questionnaire score',
  `Inflammatory_Arthritis` int NOT NULL COMMENT 'Inflammatory Arthritis Status (Yes=1,
No=0)',
  `Exam_date` date NOT NULL COMMENT 'Date of the exam',
  `BMI` float NOT NULL COMMENT 'Body Mass Index',
  `SBP` float NOT NULL COMMENT 'Systolic Blood Pressure',
  `DBP` float NOT NULL COMMENT 'Diastolic Blood Pressure',
  `Smoking_Status` int NOT NULL COMMENT 'Smoking_Status(Yes=1, No=0)',
  `Diabetes` int NOT NULL COMMENT 'Diabetes Status(Yes=1, No=0)',
  PRIMARY KEY (`Patient_id`) USING BTREE,
  CONSTRAINT `Pid` FOREIGN KEY (`Patient_id`) REFERENCES `patient` (`Patient_id`) ON
DELETE RESTRICT ON UPDATE RESTRICT
) ENGINE = InnoDB CHARACTER SET = utf8mb4 COLLATE = utf8mb4_0900_ai_ci
ROW_FORMAT = Dynamic;
```

2. Data Loading

(1) Insert the data into table Patient

```
INSERT INTO `patient` VALUES ('10001', 'Malyn', 0, 'F', '1997-05-06', 'Asian', 'Associate degre',
'JaneSmithChicago@ESP.com', '14530192012');
INSERT INTO `patient` VALUES ('10002', 'Jonet', 0, 'F', '1995-06-10', 'White', 'Bachelor\'s
degree', 'MayurDikShit@example.com', '10018585115');
INSERT INTO `patient` VALUES ('10003', 'Alise', 0, 'F', '1992-05-09', 'Black or African
American', 'Associate degre', 'Google@example.com', '17417413005');
INSERT INTO `patient` VALUES ('10004', 'Salove', 0, 'F', '1998-10-11', 'Hispanic or Latino',
'High school diploma or equivalent', 'party@college.edu', '12054232319');
INSERT INTO `patient` VALUES ('10005', 'Acelina', 0, 'F', '2000-05-30', 'American Indian or
Alaska Native', 'High school diploma or equivalent', 'ironman@timgarage.com', '13469515966');
......
INSERT INTO `patient` VALUES ('10019', 'Elyscia', 0, 'M', '2010-05-03', 'American Indian or
Alaska Native', 'Bachelor\'s degree', 'pr2ess@yourdomain.com', '16808851773');
INSERT INTO `patient` VALUES ('10020', 'Typhenete', 0, 'M', '2001-07-09', 'American Indian or
Alaska Native', 'Associate degre', 'h12345i@example.com', '16864974651');
INSERT INTO `patient` VALUES ('10021', 'Gifford', 0, 'F', '2003-05-06', 'Hispanic or Latino',
'High school diploma or equivalent', 'seres@yourdomain.com', '11922096352');
SET FOREIGN_KEY_CHECKS = 1;
```

(2) Insert the data into table Pancreatic_Cancer

```
INSERT INTO `pancreatic_cancer` VALUES ('10001', '0', 0, '2018-01-03');
INSERT INTO `pancreatic_cancer` VALUES ('10002', '0', 1, '2019-04-09');
INSERT INTO `pancreatic_cancer` VALUES ('10008', '1', 0, '2019-05-19');
INSERT INTO `pancreatic_cancer` VALUES ('10009', '0', 0, '2019-03-20');
INSERT INTO `pancreatic_cancer` VALUES ('10011', '1', 1, '2018-05-30');
INSERT INTO `pancreatic_cancer` VALUES ('10016', '1', 0, '2018-04-21');
INSERT INTO `pancreatic_cancer` VALUES ('10017', '0', 1, '2019-05-05');
```

(3) Insert the data into table IA_Test_Record

```
INSERT INTO `ia_test_record` VALUES ('10001', 5, 0, -1, 1, '2018-01-03', 18.5, 111, 80, 1, 1);
INSERT INTO `ia_test_record` VALUES ('10002', 3, 1, 5, 1, '2019-04-09', 23, 119, 80, 0, 1);
INSERT INTO `ia_test_record` VALUES ('10003', 18, 1, 3, 1, '2018-04-05', 22.8, 120, 82, 0, 0);
INSERT INTO `ia_test_record` VALUES ('10004', 11, 1, 7, 1, '2018-04-05', 25.6, 145, 92, 1, 1);
INSERT INTO `ia_test_record` VALUES ('10005', 1, 1, 3, 1, '2019-06-10', 24.3, 180, 110, 0, 1);
INSERT INTO `ia_test_record` VALUES ('10006', 16, 0, 1, 1, '2020-01-30', 21.8, 165, 107, 1, 1);
INSERT INTO `ia_test_record` VALUES ('10007', 5, 0, 14, 1, '2020-06-15', 22.7, 125, 82, 0, 1);
```

Run and Test

(1) New Patient Registration

Input the personal information into the Patient Information. Using the SQL code:

```
INSERT INTO `patient` VALUES ('10022', 'Iya', 0, 'F', '2010-03-01', 'American Indian or Alaska Native', 'Bachelor\'s degree', 'IYA@gmail.com', '16777851773');
```

(2) Patient Information Query

Input the patient's first name, last name and birth date, we can get the personal information of the patient and also the patient id for the further query. Using the SQL code:

```
SELECT * FROM patient
WHERE first_name = "Malyn" AND last_name = "Ayleth" AND Birth_Date = "1997-5-6"
```

(3) Patient Exam Query

Input the patient id into the Patient Information. Using the SQL code:

```
SELECT * FROM IA_Test_Record
WHERE Patient_id = 10010
```

Or we can input the patient's first name, last name and birth date, we can get the exam information of this patient. Using the SQL code:

```
SELECT * FROM patient
WHERE patient_id in (SELECT patient_id FROM patient WHERE first_name = "Malyn" AND last_name = "Ayleth" AND Birth_Date = "1997-5-6")
```

(4) New Exam Update

Input the new exam information into the Patient Information. Using the SQL code:

```
INSERT INTO `ia_test_record` VALUES ('10001', 6, 0, 0, 1, '2018-02-03', 18.7, 110, 81, 1, 1);
```