# CLINICAL TRIALS DATABASE

CMPS 3420 SPRING 2018
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# 1.1 Fact Finding Techniques and Information Gathering

To build a database for an organization that is conducting clinical trials, we first must see what is required and what is needed of the database. Section one is about pre-planning. We must gather information and make visual representation of what we want to be within our database.

## 1.1.1 Introduction to Organization

For us to create this database, we must first understand this business. Section 1.1 will be on what the organization does daily. In the world of test drugs and other medical advances there must always be clear and concise documentation. There are a number of important factors to keep track of which include: doctors, subjects, sites, appointments, etc. The overall goal of this organization, is to eventually find helpful drugs/equipment that will better the lives of those of are hindered by disabilities of many varieties.

## 1.1.2 Description of Fact-Finding Techniques

To effectively create a database, those creating must interview those will actually be interacting with the database. We gathered our information by first interviewing a group working out of the San Gregornio Hospital in Beaumont CA. Between that, some internet searching, and our intuition, we've assembled as closely as possible a system we believe can meet the needs of nearly any Clinical Trial Management group.

## 1.1.3 Conceptual Database

The business of Clinical Trials is massive. We will not be able to cover the entity of the whole industry, so we will be covering one fictitious company. Our 'miniworld' will contain a company that will conduct multiple studies, have multiple doctors and patients, multiple sites, and other key factors that will be covered in section 1.2. The overall goal is to make the process of starting, conducting, and completing a Clinical Trial as efficient as possible while retaining as much useful data as possible to report on later. Regulatory information, patient results, visit records, and any other form that needs to be completed already exists in the real world, so we will only be storing that information in the form the most common file types in our Document Info table (PDF's, Word, Excel, Text, ect.). To remain compliant with existing laws regarding sensitive personal information, access to documents associated with a study will be limited to certain User Types.

## 1.1.4 Entity and Relationship Sets Description

This section will contain a basic over view of our entity sets as well as our relationship sets.

## ENTITY TYPES:

 Doctor: docPID, docName, docDescription

A doctor works at a site and is assigned to a particular study. They have an ID, a name, and a description of their specializations.

- Subject: subID, subInitials, subGender, subDateOfBirth, subAge, subHeight, subWeight, subBloodType

The subjects are the most important entity to keep track of because through them we will know if a prototype has an effect or not. Due to this they contain a lot of attributes that pertain to personal and physical information.

- Site: sitPID, sitName, sitDescription, sitLocation?

The sites will be where the particular projects take place. So, they must include an ID, a name of the site, a description, and a location.

- Project: proPID, proName, proDescription

Projects will be another main focus in this company, they include an ID, name, and a detailed description.

- Study: stuPID, stuName, stType, stuEnrollmentGoal

Another critical part of the companies are the studies, which will be the main brain that gets the information from subjects, doctors, and also handles documents.

- Study_Arm: sarPID, sarName, sarDescription

The study arms will be a branch of a particular study, it will be working on a different section of the study. So, it includes, an ID, a name, and a description.

- Activity: actPID, actName, actDescription, actDuration, actCost

Activities will be tasks that the subjects using prototypes are going to asked to perform in order to see what effects they have. They include: an ID, a name, a description, the duration, and cost.

- Visit: visPID, visName, visDescription, visStartDateTime, visEndDateTime

Visits will be primarily just to check the progress of a subject and they will include: an ID, a name, a description, and a start/end time.

- Appointments: appPID, appStartDateTime, appEndDateTime

Appointments will come about if there is an activity and/or a visit scheduled. They include: an ID, a name, and a start/end time.

- Sponsor: spoPID, spoName, spoDescription

As the name states, sponsors are the entity that provide the funding for the project. A sponsor includes: an ID, a name, a description.

- Document: docPID, docDescription, docFileName, docFileType, docBLOB, docVersion

Documents are essential to this company because that is how results and progress is kept. Documents will include: an ID, a name, a file name, file type, a BLOB, and a version of the document.

## RELATIONSHIP TYPES:

Doctors works at site:

Cardinality: 0..1

Participation: partial, total

Site Hosts a project:

Cardinality: 0..*

Participation: partial, total

pays for project:

Cardinality: 0..*

Participation: partial, total

Study has documents:

Cardinality: 0..*

Participation: partial, total

Activity is a part of study arm:

Cardinality: 0..*

Participation: partial, total

Visit is a part of a study arm:

Cardinality: 0..*

Participation: partial, total

Appointment is generated from an activity/visit:

Cardinality: 1..*

Participation: partial, total

Appointment is completed by a subject:

Cardinality: 0..*

Participation: partial, total

Appointment is conducted by doctor:

Cardinality: 0..1

Participation: partial, total

Appointment is linked to study arm:

Cardinality: 0..*

Participation: partial, total Sponsors

### 1.1.5 User Groups, Data Views, and Operations

This section will contain details about the types of Users who will be interacting with our database, what kind of access they will have (permissions) and the kinds of data they will need to see. (Completed at Phase V)

## 1.2 Conceptual Database Design

To better grasp the scope and limitations of our data model, this section is dedicated to mapping the relations and relationships between entities using different methods. Additionally, the information below will provide the reader with specifics about integrity constraints in our database fields.

### 1.2.1 Entity Set Description

Below is an outline of all the entities listed in our ER Diagram, as well as their corresponding field names and integrity constraints.

**User**

| | *usePID* | *useName* | *usePassword* | *useType* |
|---|---|---|---|---|
| *Description* | This ID is used to uniquely identify a User. | This is used to provide the user with a unique string of characters needed for logging in | This field stores the password created for the User. The value should be hashed & salted for added security. | This field is an integer used as a reference for the User Type table |
| *Domain/Type* | integer | varchar(50) | varchar(50) | integer |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum 50 | All positive integers |
| *Default Value* | NASK | None | None | 3 |
| *Nullable?* | No | No | No | No |
| *Unique?* | Yes | Yes | No | No |
| *Single or Multiple Value* | Single | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple | Simple |

-- Candidate keys: usePID, useName
-- Primary key: usePID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: usePID, useName

**User Type**

| | *utyPID* | *utyName* | *utyDescription* |
|---|---|---|---|
| *Description* | This ID is used to uniquely identify a User Type. | This is a descriptive label assigned to a User Type for clarity. | This field stores the description of the particular User Type to be referenced when needed. |
| *Domain/Type* | integer | varchar(50) | varchar(200) |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum 200 |
| *Default Value* | NASK | Un-named Type | NULL |
| *Nullable?* | No | No | Yes |
| *Unique?* | Yes | Yes | No |
| *Single or Multiple Value* | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple |

-- Candidate keys: utyPID

-- Primary key: utyPID
-- Strong/Weak Entity: Weak
-- Fields to be indexed: utyPID

**Site**

| | *sitPID* | *sitName* | *sitDescription* |
|---|---|---|---|
| *Description* | This ID is used to uniquely identify a Site. | This is a label applied for the User's benefit to a Site | This field stores a brief description of a Site, it could contain almost anything. |
| *Domain/Type* | integer | varchar(50) | varchar(200) |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum 200 |
| *Default Value* | NASK | None | NULL |
| *Nullable?* | No | No | Yes |
| *Unique?* | Yes | Yes | No |
| *Single or Multiple Value* | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple |

-- Candidate keys: sitPID, sitName
-- Primary key: sitPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: sitPID, sitName

**Sponsor**

| | *spoPID* | *spoName* | *spoDescription* | *spoPhoneNumber* |
|---|---|---|---|---|
| *Description* | This ID is used to uniquely identify a Sponsor. | This column holds the unique company name of the sponsor participating in Studies. | This field stores a brief description of the sponsor (to be used if needed) | This field holds the 9 digit primary phone number of a Sponsor. |
| *Domain/Type* | integer | varchar(50) | varchar(200) | integer |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum 200 | All 9-digit positive integers |
| *Default Value* | NASK | None | NULL | NULL |
| *Nullable?* | No | No | Yes | Yes |
| *Unique?* | Yes | Yes | No | No |
| *Single or Multiple Value* | Single | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple | Simple |

-- Candidate keys: spoPID, spoName
-- Primary key: spoPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: spoPID, spoName

**Doctor**

| | *docPID* | *docName* | *docSpecialization* | *docPhoneNumber* |
|---|---|---|---|---|
| *Description* | This ID is used to uniquely identify a Doctor. | This contains a Doctor's professional title, including their credential abbrevialtions | A Doctor's main area of interest within a Study will be stored here. | This field holds the 9 digit primary phone number of a Doctor. |
| *Domain/Type* | integer | varchar(75) | varchar(50) | integer |
| *Value Range* | All positive integers | String of ASCII maximum 75 | String of ASCII maximum 50 | All 9-digit positive integers |
| *Default Value* | NASK | None | NULL | Null |
| *Nullable?* | No | No | Yes | Yes |
| *Unique?* | Yes | No | No | No |
| *Single or Multiple Value* | Single | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple | Simple |

-- Candidate keys: docPID
-- Primary key: docPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: docPID

Subject

| *subPID* | *subInitals* | *subGender* | *subHeight* | *subWeight* | *subBloodType* | *subStatus* | *subSurvivalStatus* |
|---|---|---|---|---|---|---|---|
| This ID is used to uniquely identify a Subject. | This contains the first and last letter abbreviations of a Subject's name. HIPAA compliance. | The gender the Subject identifies as is stored here. | The Subject's height, in inches, is stored here. | The Subject's weight, in pounds, is stored here. | The Subject's blood type is stored here. | A Subject is either active, and can participate in Studies, or inactive, and can not. | If a Subject becomes deceased during the course of a Study, that is an important metric. |
| integer | varchar(75) | varchar(50) | integer | integer | varchar(75) | varchar(50) | integer |
| All positive integers | String of ASCII maximum 75 | String of ASCII maximum 50 | All 9-digit positive integers | All positive integers | String of ASCII maximum 75 | String of ASCII maximum 50 | 1 or 0 |
| NASK | None | NULL | NULL | NULL | NULL | 1 | 1 |
| No | No | Yes | Yes | Yes | Yes | No | No |
| Yes | No | No | No | No | No | No | No |
| Single | Single | Single | Single | Single | Single | Single | Single |
| Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple |

-- Candidate keys: subPID
-- Primary key: subPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: subPID

**Study**

| | *stuPID* | *stuName* | *stuDescription* | *stuEnrollmentGoal* |
|---|---|---|---|---|
| *Description* | This ID is used to uniquely identify a Study. | Every Study is assigned a Name, typically referring to the type of drug or technology used. | A Study name may be insufficient for the average person to understand the point of the study, so it is explained in more detail here. | All Studies have a Subject Total goal that they try to reach, that is stored here. |
| *Domain/Type* | integer | varchar(50) | varchar(MAX) | integer |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum (SQL MAX) | All positive integers |
| *Default Value* | NASK | None | NULL | NULL |
| *Nullable?* | No | No | Yes | Yes |
| *Unique?* | Yes | No | No | No |
| *Single or Multiple Value* | Single | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple | Simple |

-- Candidate keys: stuPID
-- Primary key: stuPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: stuPID

**Study Arm**

| | *sarPID* | *sarName* | *sarDescription* |
|---|---|---|---|
| *Description* | This ID is used to uniquely identify a particular Arm of a Study. | This is a label for a particular Arm attached to a Study. (Will normally be "1" or "main") | This field stores a brief description of a Study Arm, it could contain almost anything. |
| *Domain/Type* | integer | varchar(50) | varchar(200) |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum 200 |
| *Default Value* | NASK | None | NULL |
| *Nullable?* | No | No | Yes |
| *Unique?* | Yes | Yes | No |
| *Single or Multiple Value* | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple |

-- Candidate keys: sarPID
-- Primary key: sarPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: sarPID

**Visit**

| | *visPID* | *visName* | *visDescription* | *visStart* | *visEnd* |
|---|---|---|---|---|---|
| *Description* | This ID is used to uniquely identify a Visit | Each Visit will have a (non-unique) label associated with it. Most of the time it will be a number, but not always. | Purely an optional field, populated before or after a Visit if a special note is required (i.e. Subject dies) | This DateTime field holds the estimated start day and time of a particular Visit for a particular set of Subjects. | The estimated ending day and time of a visit is stored here. |
| *Domain/Type* | integer | varchar(50) | varchar(100) | DateTime | DateTime |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum 100 | Any Date & Time after 1/1/1900 | Any Date & Time after 1/1/1900 |
| *Default Value* | NASK | None | NULL | DateTime(Now) | DateTime(Now) |
| *Nullable?* | No | No | Yes | No | No |
| *Unique?* | Yes | No | No | No | No |
| *Single or Multiple Value* | Single | Single | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple | Simple | Simple |

-- Candidate keys: visPID
-- Primary key: visPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: visPID

**Activity**

| | *actPID* | *actName* | *actDescription* | *actDuration* | *actCost* |
|---|---|---|---|---|---|
| *Description* | This ID is used to uniquely identify an Activity | All Activities are assigned a unique name in Medicine (EKG, Blood Draw, Physical) | If the actName is insufficient to describe an Activity, it may be explained in more detail here | The amount of time (in minutes) that an Activity is expected to take is stored here. | Activities are assigned a cost to be later reported on by Study, by Patient, or by Activity |
| *Domain/Type* | integer | varchar(50) | varchar(75) | integer | Decimal(8,4) |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum 75 | All positive integers less than 720 | Any decimal number 8 digits before the decimal and 4 digits after. |
| *Default Value* | NASK | NULL | None | Null | 1 |
| *Nullable?* | No | Yes | No | Yes | No |
| *Unique?* | Yes | No | No | No | No |
| *Single or Multiple Value* | Single | Single | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple | Simple | Simple |

-- Candidate keys: actPID
-- Primary key: actPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: actPID

**Appointment**

| | *appPID* | *appStartTime* | *appEndTime* | *appCompleted* |
|---|---|---|---|---|
| *Description* | This ID is used to uniquely identify an Appointment | All Appointments are given a name generated from a combination of values from the Visit & Activity & Subject data it applies to. Inherited from Visit, then modified by User. | All Documents that are selected will have their base filenames saved here. Inherited from Visit, then modified by User. | This is a status field, which should be marked completed at the conculsion of an appointment. When all appointments for a study are completed, the Study is completed |
| *Domain/Type* | integer | varchar(50) | DateTime | DateTime |
| *Value Range* | All positive integers | String of ASCII maximum 50 | Any Date & Time after 1/1/1900 | Any Date & Time after 1/1/1900 |
| *Default Value* | NASK | Inherited | DateTime(Now) | DateTime(Now) |
| *Nullable?* | No | No | No | No |
| *Unique?* | Yes | Yes | No | No |
| *Single or Multiple Value* | Single | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple | Simple |

-- Candidate keys: appPID
-- Primary key: appPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: appPID

**Document Info**

| | *docPID* | *docDescription* | *docFileName* | *docBLOB* | *docVersion* |
|---|---|---|---|---|---|
| *Description* | This ID is used to uniquely identify a Document | This field allows Users uploading Documents to assign a new name to a particular file. The filename is retained in a separate field. | All Documents that are selected will have their base filenames saved here. | This field holds the 9 digit primary phone number of a Sponsor. | This field stores a brief description of the sponsor (to be used if needed) |
| *Domain/Type* | integer | varchar(50) | varchar(MAX) | varbinary(MAX0 | varchar(200) |
| *Value Range* | All positive integers | String of ASCII maximum 50 | String of ASCII maximum (SQL MAX) | String of ASCII maximum (SQL MAX) | Any positive integer |
| *Default Value* | NASK | NULL | None | Null | 1 |
| *Nullable?* | No | Yes | No | Yes | No |
| *Unique?* | Yes | No | No | No | No |
| *Single or Multiple Value* | Single | Single | Single | Single | Single |
| *Simple or Composite* | Simple | Simple | Simple | Simple | Simple |

-- Candidate keys: dinPID
-- Primary key: dinPID
-- Strong/Weak Entity: Strong
-- Fields to be indexed: dinPID

### 1.2.2 Relationship Set Description

Below is a detailed description of all the relationships presented in our ER diagram, as well as some key information about the entities involved and the cardinality of each relationship.

## Creates

The Creates relationship connects a User to a Study. Users will create and configure a Study to involve one or many Subjects, Doctors, Activities, Visits, and Appointments.

Mapping cardinality: 1:M
Descriptive field: None
Participation Constraint: Mandatory for Study

## Hosts

The Hosts relationship connects a Site to a Study. Most Appointments for a Subject are completed at a Site, rarely it will be held off-site. In that event, a NULL will be recorded.

Mapping cardinality: 1:M
Descriptive field: None
Participation Constraint: Optional for Study

## Pays For

The Pays For relationship connects a Sponsor to a Study. All Studies, without exception, are paid for by a single Sponsor. A Sponsor does not necessarily need to have any Studies associated with them, but all Studies require one.

Mapping cardinality: 1:M
Descriptive field: None
Participation Constraint: Mandatory for Study

## Has

The Has relationship connects a Study to Document. All Studies, without exception, will have many Documents associated with them. A Study is not required to have a certain number of documents associated with it, but a Document must always be associated with a Study.

Mapping cardinality: 1:M
Descriptive field: None
Participation Constraint: Mandatory for Document

## Conducts Studies At

The Conducts Studies At relationship connects a Doctor to a Site. A Doctor may work at various sites, but only participate in a Study at a single Site. A Site does not need to have Doctors associated with it, but a Doctor must be linked to one or more Sites.

Mapping cardinality: 1:M
Descriptive field: None
Participation Constraint: Mandatory for Doctor

## Assigned To

The Assigned To relationship connects Doctors and Subjects to a Study. Both Doctors and Subjects may be linked to one or more Studies, but Studies may not link to any Subject or Doctors at the beginning.

Mapping cardinality: M:M
Descriptive field: None
Participation Constraint: Mandatory for Study, Mandatory for Subject, Mandatory for Doctor

## Part Of

The Part Of relationship connects Activities and Visits to a Study Arm. Any number of Visits and Activities may be connected to a single Arm, and an Arm can be connected to multiple Visits and Activities.

Mapping cardinality: M:M
Descriptive field: None
Participation Constraint: Mandatory for Visit, Mandatory for Activity, Mandatory for Study Arm

## Linked To

The Linked To relationship connects Appointments to a Study Arm. A Study arm may have many appointments, but an Appointment can only be connected to a single Arm.

Mapping cardinality: M:1
Descriptive field: None
Participation Constraint: Mandatory for Appointment

## Generated From

The Generated From relationship connects Appointments to Visits and Activities. All Appointments are generated from some Activity scheduled for a certain numbered Visit for a certain Subject. All Appointments must be linked to a Visit & Activity, though if it isn't scheduled, Visits and Activities won't necessarily be used to generate an Appointment. An Appointment can also be added regardless of Visits and Activities

Mapping cardinality: M:1
Descriptive field: None
Participation Constraint: Optional for Appointment

## Conducted By

The Conducted By relationship connects Appointments to Doctors. All Appointments are assigned a Doctor who will ensure the Subject completes the Activity. All Appointments have a single Doctor, but a Doctor might have several Appointments.

Mapping cardinality: M:1
Descriptive field: None
Participation Constraint: Mandatory for Appointment

## Completed By

The Completed By relationship connects Appointments to Subjects. All Appointments are created for a Subject. A Subject may have multiple Appointments, but an Appointment will only have a single Subject.

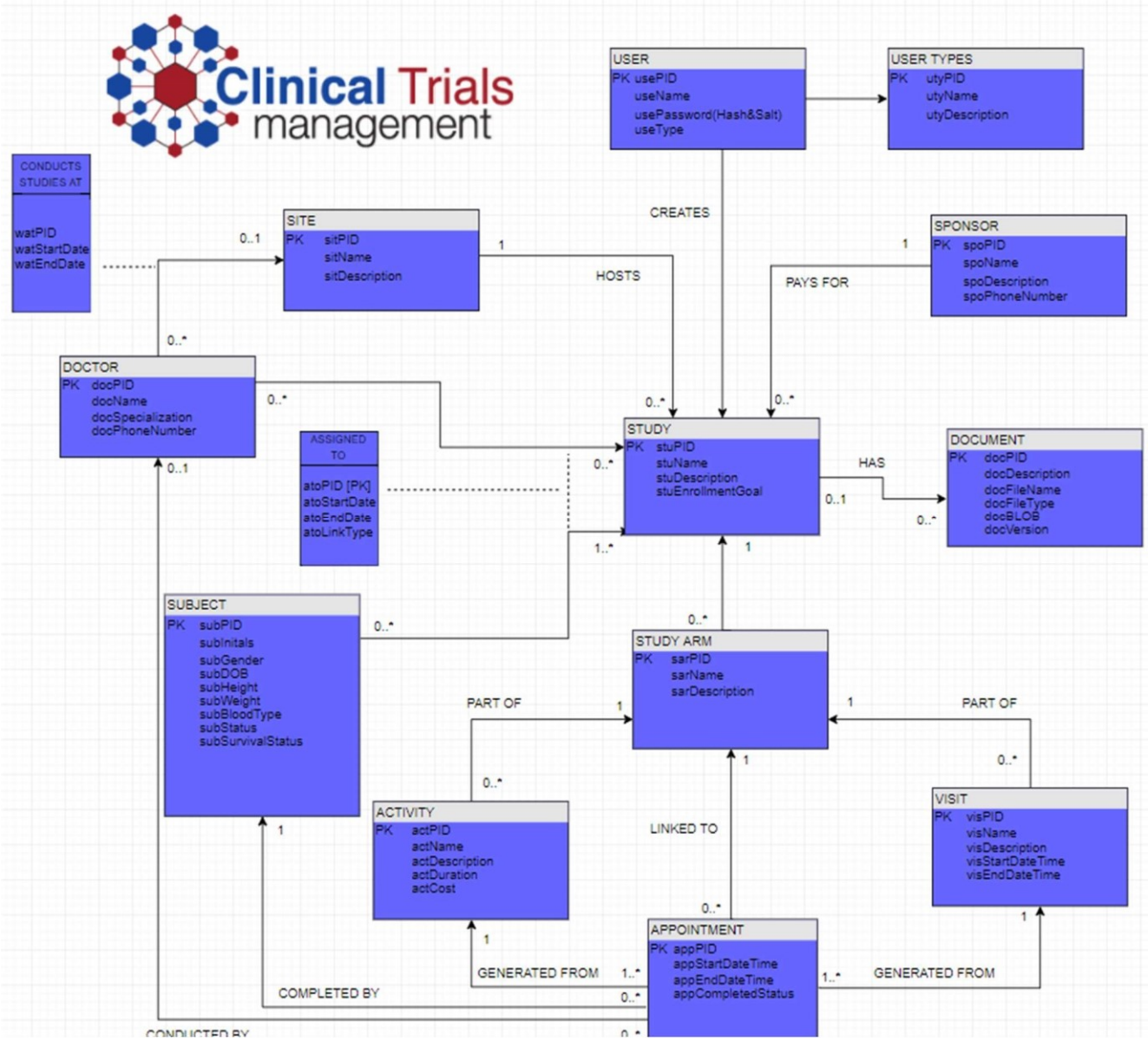
Mapping cardinality: M:1
Descriptive field: None

Participation Constraint: Mandatory for Appointment

### 1.2.3 Related Entity Set

Super and Sub-Classes are not used in our design, instead we've elected to create several related tables that will allow us to manage multiple Studies from any Site, using any Doctors, with any Subjects, paid for by any Sponsor, which could any number of Documents.

### 1.2.4 ER Diagram




## 2. Conceptual Database and Logical Database

First we began with the conceptual database which is exactly what the name suggest, it made to give an idea of what the database will look like. The logical database is a translation of the conceptual model but with more implementation in mind. Just like how when a car company unveils a concept, the final product that is available to the public does not look exactly like the concept.

To achieve the logical database, we must convert our E-R model to a relational model. The relational model will be closer to the database itself then the E-R model. Things like relationships do not exist and their function is replaced by foreign keys and such. After this model is created we will be able to create sample queries that will be used as a foundation for what our database will be able to handle.

## 2.1 E-R Model and Relational Model

The E-R model describes a conceptual database design. A relational model describes a logical design that will be closer to application, or in other words more realistic. The following will be regarding these two different types of models.

### 2.1.1 Description of E-R Model and Relational Model

The E-R model was first introduced by a developer named Peter Chen in 1976. Chen was a graduate from National Taiwan University. The main and most important objective of this model is for it to very easily readable and user friendly to everyone. People must be able to be look at the model and understand what the idea of this database is. The model is also meant to tie together what the organization wants and what the engineers behind the database wants to do. It is a bridge between the creator of the database and the business it is for.

The relational model was created by Edgar F. Codd in 1969. This model is less about simplicity and more about mirroring the actual way the database will look. It is meant more for the developers of the database. This model is more related to the creation of queries as this model does not have features that are not supported. Everything that is used to create this model can be applied to the vast majority of database management systems. It is structured around the idea of building blocks and those blocks are the relations.

When it comes to comparisons between them there are some that are important to point out. For one, the relational model, as previously stated, relies on the idea of the relation. The E-R model relies on two ideas, the entity, and the relationship. The relationships are formed between the entities to relate them and connect them. Within the entities are attributes which are used to describe the purpose the entity. The relational model relies on the relation and within the relation there may be tuples which could be correlated to the attributes of the E-R model.

### 2.1.2 Comparison of Two Different Models

There are advantages to the E-R model. The primary one is the ease of understanding. It is basically the purpose the model. It is the ease of communication between developer and customer. The mathematical basis of the relational model is not present in the E-R model. But this is also a disadvantage. Because it does not have a mathematical basis, it can not be used with any formal query language. No database management system(DBMS) does NOT support the ER model. Another issue here is that there is no standard behind the E-R model. This can lead to major issues between developers.

The same can be said about the relational model. One of advantages is one the disadvantages of the E-R model. The relational model does have a standard and it is based on mathematics. Because of this query languages do support this model. It is far easier to implement the idea of the model into software. But there are disadvantages which are basically the advantages of the E-R model. It is hard to understand unless the person looking it over has prior knowledge in the field. It is not meant to be used to as communication with the customer.

The main difference between the two, however, is the purpose for which they were created for. The E-R model is primarily geared to be user friendly and easier to understand. Due to this fact it is not practical to implement the design behind this model to the software. This is where the relational model comes in. The relation model is meant more for the creator rather than the customer who wants the database. The relational model is closer to the development of the software. Despite these differences, there are similarities. They are both intended to demonstrate the structure that the data must be in. A relation schema is the equal of the entity and relationship types.

## 2.2 Conversion of Conceptual Database Model to Logical Database Model

Having thoroughly described the both the E-R and the relational model, now it is time to do the conversion from E-R to relational. The first item that will be done is to go through the process of converting the entity types then the relation types. Finally, will go through the process of constructing the constraints that we will need to handle in order to maintain integrity of the database.

### 2.2.1 Converting Entity Types to Relations

We now have to convert the entity types into relation schemas. This is required when doing a conversion from E-R Model to Relational model. In a sense, relation schemas are much simpler than the complex E-R model because the relation schemas will have single valued domains. This following section will be dedicated to how we will go about this conversion.

When it comes to the conversion of a strong entity into a relation is quite simple. The new relation will retain its name and the attributes will be single value. They will also contain the entity type's composite attributes. One of the key attributes of the entity type will eventually become the primary key of the relation. The remaining key attributes of the entity will simply become candidates. These candidates are unique, but they are not used to identify the relation.

There are also weak entities that must be converted to relations. The way this is done is by making this weak entity into a strong one. The weak entity will contain partial key attributes amongst others. These can be used to form a foreign key that can used to uniquely identify the relation. If it is still weak then uniqueness must be added to the relation to make it stronger. Once a suitable key is found than the steps above can be followed because this entity is now considered strong.

We must also appropriately handle simple and composite attributes. Simple attributes simply become attributes of the relation. However, composite attributes must be taken apart and only the simple parts of each are used as attributes in the relation. Along with this we must also handle the attributes that may have single or multi values. As before with simple attributes, single value attributes simply become attributes that will go with the corresponding relation. Multi-value attributes are different. Each multi-value attribute must now become a new relation. Along with this the attributes that go in this new relation are the same ones that were originally in the multi-value attribute. A foreign key is also taken from a relational schema that happens to

be a primary key for it. The foreign key and the multi-value attribute are combined to create the primary key the new relation created from the original multi-value variable.

### 2.2.2 Converting Relationship Types to Relations

Another step in the conversion is the conversion of relationship type to relations. This especially difficult because this concept does not actually exist in the relation model. There are a couple of scenarios that can be found when doing this conversion and here we will cover them.

1:1 Cardinality: When a relationship has a cardinality of 1:1 than both relationship types (A and B) must be converted into relations R1 and R2. Then each instance of R1 must be paired with its match in R2. This can be done in three ways:

1. Merged Relation Approach: This simply brings in both R1 and R2 into one relation.
2. Foreign Key Approach: Here the primary key of R1 is made into a foreign key of R2. Or the other way around. This will ensure that the attributes of the relationship will become attributes of the relation.
3. Cross-Reference Approach: In this approach, a new relation is created. This new relation will contain the primary keys of both R1 and R2 as foreign keys. It will also take the simple attributes of the of the relationship.

1:N Cardinality: As before, the relationship types must be converted into relations, R1 and R2. Each instance of R1 must be related to multiple instances of R2. However, each instance of R2 must be related to one instance of R1. There are two methods to deal with this:

1. Foreign Key Approach: Same as the 1:1 cardinality, however, the foreign key and the attributes must all come from R2. This is so because R2 can only be related to one instance of R1.
2. Cross-Reference Approach: Once again this is the same as the 1:1 cardinality, with the difference that the primary key of the new relation must be the foreign key of the R2 relation.

M:N Cardinality: Once again, we must convert to R1 and R2. However, each instance of R1 can be related to multiple instances of R2. And each instance of R2 can be related to multiple instances of R1. There is only one way to deal with this and it is the Cross-Reference Approach. The primary keys of R1 and R2 are used as foreign keys in the new relation.

"isA" Relationship: This occurs when enrity types are disjoint subclasses of one superclass. One entity belongs to on subclass. The three methods to deal with this are as follows:

1. Multiple Relations w/ Superclass & Subclass : Here two relations are needed. One called R_Super and the other called R_Sub. Each will contain the corresponding attributes from the entity. In addition to the attributes found within the R_Sub relation, it will also contain the primary key of the R_Super relation as a foreign key.

2. Multiple Relations w/ Subclass: With this approach, subclass entities are given their own relation. These relations contain a union of the attributes of the superclass and the subclass. If overlapping happens then the appropriate subclasses must all contain the same primary key. (BEST APPROACH)
3. Single Relation w/ One attribute: Only one relation is created and the attributes come from a union of attributes from the one superclass and all the subclasses.

"hasA" Relationship: This occurs when entity types are overlapping subclasses of one superclass. One entity can belong to multiple subclasses. The two methods to mend this are as follows:

1. Multiple Relations w/ Superclass & Subclass: Same exact approach as "isA" relationship
2. Multiple Relations w/ Subclass: With this approach, subclass entities are given their own relation. These relations contain a union of the attributes of the superclass and the subclass. This also contain a Boolean attribute for the subclasses that will indicate "true" if then the instance belongs to that subclass.

When a relationship type associates itself with another relationship type, the best thing that can be done is to create a primary key attribute for the relationship type. Then once both are linked, either the foreign key or the cross-reference approach may be used.

Recursive Relationship: This occurs when one entity type is related to itself. There are two ways deal with this:

1. Foreign Key Approach: The relation will simply have a foreign key that will be the primary key o the relation itself.
2. Cross-Reference Approach: This approach requires the creation of a new relation. This relation will contain two foreign keys that will reference the primary key of the original relation. The combo of both foreign keys will create a primary for the new relation.

When two or more entity types are involved in a relationship, there is a way to deal with it. When this happens, the relationship is turned into one relation. This relation, will contain foreign keys of the other entities' primary keys. These foreign keys will create the primary key of the new relation.

A union type happens when a subclass belongs to multiple superclasses. These relations that correspond to the different superclasses will have different primary keys, so to mend this a surrogate key must be created. It is also possible to share the same surrogate key in the even that multiple superclasses are associated to one subclass.

### 2.2.3 Database Constraints

Constraints exist because it is critical for the correct and appropriate data to be inputted. It must have some meaning to it. There are a set of constraints that we cannot go past because it

will destroy the integrity of the database. This section will go over the constraints that must be enforced.

Domain Constraints: These constraints revolve around a domain. Each attribute has a domain that will specify what can and cannot be inputted. An example is only accepting certain data types. If this constraint is ignored the DB will reject and could instead set the value to NULL.

Entity Constraint: This constraint requires that all tuples that belong to a particular relation, have a primary key that is not NULL. The reason behind this is to make sure that each tuple can be uniquely identified.

The DBMS can make sure these constraints are ignored by rejecting UPDATE and INSERT operations.

Referential Constraint: This requirement requires that if there exist a reference between two relations using a primary key and a foreign key, then the tuple that was reference must exist. If there is an R1 relation with a tuple T1 that is a foreign key that references another relation R2, then T1 must match T2 which is found somewhere in R2.

Check Constraints and Business Rules: All the constraints that were described above were designed to follow the rules of DBMS. They were constraints that present themselves when there is a conversion between E-R and relation. However, some rules emerge based on the application of the DB. These rules are presented by the business that will be using the DB. These rules will be enforced by the designers to make sure that the users' expectations are followed and that the data satisfies what is needed for the application.

## 2.3 Convert Entity Relationship Model to Relational Model

### 2.3.1 Relational Schema for Logical Database Relation Schema: Study

study(stuPID, stuName, stuDescription, stuEnrollmentGoal, stuCompleted, stuSponorLinkID, stuSiteLinkID) Attributes:

| | |
|---|---|
| *stuPID | Integer, Primary Key |
| stuName | Varchar(100) |
| stuDescription | Varchar(250) |
| stuEnrollmentGoal | Integer |
| stuCompleted | Integer(1 or 0) |
| stuSponsorLinkID | Integer, Foreign Key |
| stuSiteLinkID | Integer, Foreign Key |

Candidate Keys: stuPID, stuSponsorLinkID, stuSiteLinkID

Entity Integrity Constraint: “stuPID” must me unique and not equal to NULL

Uniqueness Constraint: “stuPID” must be unique

Business Constraint: A Study always happens at a Site, but a Study may not always be assigned a Sponsor.

Derivation From Entity and Relationship Types: Study, Sponsor, Site, Document, Subject, Doctor

Study is derived from the Study entity type. Foreign Key’s are used to represent the relationship to Sponsor and Site. Documents, Subjects, and Doctors are also assigned to a Study using the “stuPID” as a foreign keys in those relations.

### Relation Schema: Study Arm

studyArm(sarPID, sarName, sarDescription, sarStudyLinkID) Attributes:

| | |
|---|---|
| *sarPID | Integer, Primary Key |
| sarName | Varchar(250) |
| sarDescription | Varchar(250) |

| | |
|---|---|
| sarStudyLinkID | Integer, Foreign Key |

Candidate Keys: sarPID, sarStudyLinkID

Entity Integrity Constraint: “sarPID” must me unique and not equal to NULL

Uniqueness Constraint: “sarPID” must be unique

Business Constraint: Many Study Arms can be part of the same Study

Derivation From Entity and Relationship Types: Study Arm, Study, Activity, Visit, Appointment

Study Arm is derived from the Study Arm entity type. To represent the relationship between a Study Arm and a Study, a foreign key is used. In the Visit, Activity, and Appointment relations, foreign keys are also used to represent their relationship to a Study Arm. All attributes are single valued.

Relation Schema: Activity activity(actPID, actName, actDescription, actDuration, actCost, actStudyArmLinkID) Attributes:

| | |
|---|---|
| *actPID | Integer, Primary Key |
| actName | Varchar(50) |
| actDescription | Varchar(255) |
| actDuration | Integer |
| actCost | Float(12,4) |
| actStudyArmLinkID | Integer |

Candidate Keys: actPID, actStudyArmLinkID

Entity Integrity Constraint: “actPID” must me unique and not equal to NULL

Uniqueness Constraint: “actPID” must be unique

Business Constraint: Many Activities can be linked to the same Study Arm

Derivation From Entity and Relationship Types: Study Arm, Appointment

Activity is derived from the Activity entity type. To represent the relationship between an Activity and a Study Arm, a foreign key is used. A foreign key is also used in the Appointment relation to show the relationship between itself and an Activity. All attributes are single valued.

## Relation Schema: Visit

visit(visPID, visName, visDescription, visStartDate, visEndDate, visStudyArmLinkID)
Attributes:

| | |
|---|---|
| *visPID | Integer, Primary Key |
| visName | Varchar(50) |
| visDescription | Varchar(255) |
| visStartDate | Datetime |
| visEndDate | Datetime |
| visStudyArmLinkID | Integer, Foreign Key |

Candidate Keys: visPID, visStudyArmLinkID

Entity Integrity Constraint: “visPID” must me unique and not equal to NULL

Uniqueness Constraint: “visPID” must be unique

Business Constraint: Many Visits can be linked to the same Study Arm

Derivation From Entity and Relationship Types: Study Arm, Appointment

Visit is derived from the Visit entity type. To represent the relationship between an Visit and a Study Arm, a foreign key is used. A foreign key is also used in the Appointment relation to show the relationship between itself and an Visit. All attributes are single valued.

## Relation Schema: Appointment

appointment(appPID, appName, appDescription, appStartDate, appEndDate, appCompleted, appVisitLinkID, appActivityLinkID, appStudyArmLinkID, appSubjectLinkID, appDoctorLinkID) Attributes:

| | |
|---|---|
| *appPID | Integer, Primary Key |
| appName | Varchar(255) |
| appDescription | Varchar(255) |
| appStartDate | Datetime |
| appEndDate | Datetime |
| appCompleted | Integer(1 or 0) |
| appVisitLinkID | Integer, Foreign Key |
| appActivityLinkID | Integer, Foreign Key |
| appSubjectLinkID | Integer, Foreign Key |
| appDoctorLinkID | Integer, Foreign Key |

Candidate Keys: appPID, appVisitLinkID, appActivityLinkID, appSubjectLinkID, appDoctorLinkID

Entity Integrity Constraint: “appPID” must me unique and not equal to NULL

Uniqueness Constraint: “appPID” must be unique

Business Constraint: None

Derivation From Entity and Relationship Types: Appointment, Visit, Activity, Subject, Doctor

Appointment is derived from the Appointment entity type. Foreign keys are used to show the relation to Visits, Activities, Subjects, and Doctors of an Appointment. All Attributes are single valued.

Relational Schema: Site

site(sitPID, sitName, sitDescription) Attributes:

| | |
|---|---|
| *sitPID | Integer, Primary Key |
| sitName | Varchar(100) |
| sitDescription | Varchar(255) |

Candidate Keys: sitPID

Entity Integrity Constraint: “sitPID” must me unique and not equal to NULL

Uniqueness Constraint: “sitPID” must be unique

Business Constraint: None

Derivation From Entity and Relationship Types: Site, Study, Doctor

Visit is derived from the Visit entity type. All attributes are single valued.

Relation Schema:

Doctor

doctor(docPID, docName, docSpecialization, docPhoneNumber) Attributes:

| | |
|---|---|
| *docPID | Integer, Primary Key |
| docName | Varchar(255) |
| docSpecialization | Varchar(255) |
| docPhoneNumber | Varchar(10) |

Candidate Keys: docPID

Entity Integrity Constraint: “docPID” must me unique and not equal to NULL

Uniqueness Constraint: “docPID” must be unique

Business Constraint: A Doctor is assigned to a single Site, but could be working on any number of Studies

Derivation From Entity and Relationship Types: Doctor, Site, Study

Doctor is derived from the Doctor entity type. All attributes are single valued.

## Relational Schema: Subject

subject(subPID, subInitials, subGender, subDOB, subHeight, subWeight, subBloodType, subStatus, subSurvivalStatus)

Attributes:

| | |
|---|---|
| *subPID | Integer, Primary Key |
| subInitials | Varchar(10) |
| subGender | Varchar(25) |
| subDOB | Datetime |
| subHeight | Float(12,2) |
| subWeight | Float(12,2) |
| subBloodType | Varchar(25) |
| subStatus | Integer(1 or 0) |
| subSurvivalStatus | Integer(1 or 0) |

Candidate Keys: subPID

Entity Integrity Constraint: “subPID” must me unique and not equal to NULL

Uniqueness Constraint: “subPID” must be unique

Business Constraint: Subjects can participate in multiple Studies and be assigned of any number of Appointments.

Derivation From Entity and Relationship Types: Subject, Study, Appointment

Subject is derived from the Subject entity type. All attributes are single valued.

Relational Schema: Sponsor

sponsor(spoPID, spoName, spoDescription, spoPhoneNumber) Attributes:

| | |
|---|---|
| *spoPID | Integer, Primary Key |
| spoName | Varchar(255) |
| spoDescription | Varchar(255) |
| spoPhoneNumber | Varchar(10) |

Candidate Keys: spoPID

Entity Integrity Constraint: “spoPID” must me unique and not equal to NULL

Uniqueness Constraint: “spoPID PID” must be unique

Business Constraint: Sponsors can be assigned to any number of Studies, and is not dependent on a Site.

Derivation From Entity and Relationship Types: Sponsor, Study

Sponsor is derived from the Sponsor entity type. All attributes are single valued.

## Document Info

document_info(dinPID, dinDescription, dinFileName, dinFileType, dinBLOB, dinVersion, dinStudyLinkID) Attributes:

| | |
|---|---|
| *dinPID | Integer, Primary Key |
| dinDescription | Varchar(255) |
| dinFileName | Varchar(255) |
| dinFileType | Varchar(50) |
| dinBLOB | Varbinary(max) |
| dinVersion | Integer |

| | |
|---|---|
| dinStudyLinkID | Integer, Foreign Key |

Candidate Keys: dinPID, dinStudyLinkID

Entity Integrity Constraint: “dinPID” must me unique and not equal to NULL

Uniqueness Constraint: “dinPID” must be unique

Business Constraint: Studies can have hundreds of Documents

Derivation From Entity and Relationship Types: Document Info, Study

Document Info is derived from the Document Info entity type. A foreign key is used to show Document Info’s relation to a Study. All attributes are single valued.

## 2.3.2 Sample Data of Relation

Now we will show sets of records (tuples) that correspond to their relational schemas. Attributes will follow the horizontal, and each row will represent an instance of the relation.

**Activity**

| actPID | actName | actDescription | actDuration | actCost | actStudyArmLinkID |
|---|---|---|---|---|---|
| 1 | Blood Draw | None | 60 | 50.00 | 1 |
| 2 | MRI | Scanning | 120 | 500.00 | 2 |
| 3 | Examination | Blood pressure, bmi | 240 | 49.99 | 1 |
| 4 | Stress test | Cardio | 90 | 75.00 | 3 |
| 5 | Physical | None | 90 | 19.99 | 4 |
| 6 | Checkup | None | 30 | 0.00 | 1 |

**Appointment**

| appPID | appStartDateTime | appEndDateTime | appCompleted | appStudyArmLinkID | appActivityLinkID | appVisitLinkID | appSubjectLinkI | appDoctorLinkID |
|---|---|---|---|---|---|---|---|---|
| 1 | 2018-04-23 1:4:10 | 2018-05-10 6:47:7 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2018-04-18 7:45:6 | 2018-04-24 15:52:22 | 1 | 1 | 1 | 6 | 2 | 3 |
| 3 | 2018-04-11 13:10:30 | 2018-04-02 0:43:43 | 0 | 3 | 3 | 2 | 4 | 5 |
| 4 | 2018-04-30 9:40:8 | 2018-04-28 21:6:11 | 0 | 4 | 1 | 4 | 3 | 2 |
| 5 | 2018-05-02 6:42:27 | 2018-05-26 11:6:25 | 1 | 2 | 2 | 3 | 3 | 3 |
| 6 | 2018-04-23 6:36:1 | 2018-05-10 9:16:53 | 1 | 1 | 1 | 1 | 1 | 4 |
| 7 | 2018-05-07 2:36:42 | 2018-04-16 23:36:46 | 0 | 2 | 3 | 4 | 2 | 2 |
| 8 | 2018-04-21 19:24:25 | 2018-04-08 7:22:51 | 1 | 2 | 3 | 6 | 2 | 1 |
| 9 | 2018-04-28 17:40:26 | 2018-04-21 12:18:14 | 1 | 3 | 1 | 5 | 5 | 5 |
| 10 | 2018-04-24 21:26:37 | 2018-05-26 9:48:58 | 1 | 4 | 4 | 1 | 1 | 2 |

**Assigned To**

| atoPID | atoStartDate | atoEndDate | atoLinkType | atoSubjectLinkID | atoDoctorLinkID | atoStudyLinkID |
|---|---|---|---|---|---|---|
| 1 | 2018-05-20 10:20:25 | 2018-05-07 2:25:35 | 1 | 1 | NULL | 1 |
| 2 | 2018-04-05 10:9:51 | 2018-04-22 5:10:37 | 1 | 2 | NULL | 4 |
| 3 | 2018-05-24 4:41:28 | 2018-05-19 3:28:22 | 1 | 3 | NULL | 3 |
| 4 | 2018-05-30 5:28:52 | 2018-04-26 15:26:44 | 2 | NULL | 1 | 1 |
| 5 | 2018-04-17 18:25:20 | 2018-05-23 22:11:53 | 2 | NULL | 4 | 4 |
| 6 | 2018-05-14 20:47:13 | 2018-04-21 5:13:2 | 2 | NULL | 2 | 2 |
| 7 | 2018-05-07 3:16:55 | 2018-05-19 3:54:54 | 1 | 1 | NULL | 3 |
| 8 | 2018-04-16 11:33:6 | 2018-05-17 18:44:40 | 1 | 4 | NULL | 3 |
| 9 | 2018-05-01 19:53:55 | 2018-04-08 17:26:35 | 2 | NULL | 3 | 4 |
| 10 | 2018-04-26 13:27:47 | 2018-05-22 0:15:27 | 2 | NULL | 3 | 2 |

## Conducts Studies At

| cdaPID | cdaStartDate | cdaEndDate | cdaDoctorLinkID | cdaSiteLinkID |
|---|---|---|---|---|
| 1 | 2018-05-20 14:19:33 | 2018-04-03 23:29:35 | 1 | 5 |
| 2 | 2018-05-01 12:53:4 | 2018-04-18 12:32:50 | 2 | 4 |
| 3 | 2018-05-17 4:15:48 | 2018-04-24 6:31:31 | 4 | 3 |
| 4 | 2018-05-10 21:11:30 | 2018-04-25 6:54:12 | 3 | 1 |
| 5 | 2018-04-13 20:27:44 | 2018-04-08 12:30:43 | 5 | 2 |
| | | | | |

## Doctor

| docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|
| 1 | Tweaty | Speech Patterns | 1236781237 |
| 2 | Buggs | Olfactory Nerves | 4803475879 |
| 3 | Daffy | Study of Ornothoids | 3579810025 |
| 4 | Elmer | None | 4784268987 |
| 5 | Roadrunner | Cardiovascular Health | 4602167851 |
| | | | |

## Document

| docPID | docDescription | docFileName | docFileType | docBLOB | docVersion | docStudyLinkID |
|---|---|---|---|---|---|---|
| 1 | Recepits | receipts.pdf | "PDF" | 3423DSAi+... | 1 | 1 |
| 2 | Regulatory Document | regulatoryDocs.doc | "Doc" | 33jsDSAi+... | 1 | 3 |
| 3 | Recepits | receipts.pdf | "PDF" | 54d3DSAi+... | 2 | 1 |
| 4 | Visit Log | visitlog.pdf | "PDF" | pA+dDSAi+... | 1 | 2 |
| 5 | Visit Log | visitlog.pdf | "PDF" | 3423DSAi+... | 2 | 2 |
| 6 | Recepits | receipts.pdf | "PDF" | 3423DSAi+... | 3 | 1 |
| 7 | Recepits | receipts.pdf | "PDF" | pE3+DSAi+... | 4 | 1 |
| 8 | Regulatory Document | regulatoryDocs.doc | "Doc" | 3423DSAi+... | 1 | 2 |
| 9 | Regulatory Document | regulatoryDocs.doc | "Doc" | 3423DSAi+... | 1 | 4 |
| 10 | Recepits | receipts.pdf | "PDF" | 43sDL+Ai+... | 5 | 1 |
| | | | | | | |

## Site

| sitPID | sitName | sitDescription |
|---|---|---|
| 1 | Redlands Hospital | Hospital |
| 2 | Bob's Clinic | Clinic |
| 3 | Beaumont Hospital | Hospital |
| 4 | Bakersfield ER | Emergency services |
| 5 | LA Hospital | Hospital |
| | | |

## Sponsor

| spoPID | spoName | spoDescription |
|---|---|---|
| 1 | Really Big Pharma | None |
| 2 | Much Larger Pharma | None |
| 3 | Biggest Pharma | Cash Cow |
| | | |

## Study

| stuPID | stuName | stuDescription | stuEnrollmentGoal |
|---|---|---|---|
| 1 | New Drug | Neosporin 2.0 | 20 |
| 2 | Old Drug | Advil | 15 |
| 3 | New Technology | Heart rate monitor | 75 |
| 4 | Old Technology | Diabetes test kit | 25 |

## Study Arm

| sarPID | sarName | sarDescription | sarStudyLinkID |
|---|---|---|---|
| 1 | 1 | Main arm | 1 |
| 2 | 2 | Secondary arm | 1 |
| 3 | 1 | Main arm | 2 |
| 4 | 2 | Secondary arm | 2 |
| | | | |

## Subject

| subPID | subName | subGender | subDOB | subHeight | subWeight | subBloodType | subStatus | subSurvivalStatus |
|---|---|---|---|---|---|---|---|---|
| 1 | Mike | Male | 2010-05-18 7:9:52 | 72 | 135 | A+ | 1 | 1 |
| 2 | Jessica | Female | 2010-04-29 12:43:13 | 78 | 194 | B | 1 | 1 |
| 3 | James | Male | 2005-04-30 19:55:54 | 67 | 210 | O | 1 | 1 |
| 4 | Bobby | Male | 2010-04-22 14:33:39 | 54 | 188 | B- | 1 | 1 |
| 5 | Felicity | Female | 2010-04-27 23:4:31 | 87 | 140 | A- | 1 | 1 |
| 1 | Semore | Not Disclosed | 2001-04-06 3:6:13 | 64 | 167 | A- | 1 | 1 |
| 2 | Weird Al | Not Disclosed | 2010-05-03 21:32:26 | 63 | 152 | B+ | 1 | 1 |
| 3 | Hailey | Female | 2010-05-09 7:11:38 | 70 | 174 | O | 0 | 1 |
| 4 | Halley | Female | 2010-04-20 17:0:2 | 62 | 185 | O | 0 | 1 |
| 5 | Elvis | Male | 1930-05-02 23:27 | 58 | 138 | B+ | 1 | 0 |
| | | | | | | | | |

Visit

| visPID | visName | visDescription | visStartDateTime | visEndDateTime | visStudyArmLinkID |
|---|---|---|---|---|---|
| 1 | 1 | None | 2018-04-24 3:29:21 | 2018-05-01 3:5:51 | 1 |
| 2 | 2 | Rescheduled | 2018-04-13 6:55:16 | 2018-05-15 18:50:46 | 2 |
| 3 | 1 | None | 2018-05-08 5:55:51 | NULL | 1 |
| 4 | 2 | None | 2018-04-20 15:47:16 | NULL | 3 |
| 5 | 3 | None | 2018-04-07 3:22:13 | 2018-04-02 6:52:9 | 4 |
| 6 | 1 | None | 2018-04-11 19:58:5 | NULL | 1 |
| | | | | | |

## 2.4 Sample Queries

These are some of the queries we came up with:

1) How many appointments were completed between 1/1/2018 and 2/1/2018 for currently completed studies?
2) How many sites have more than two doctors?
3) How many subjects have an appointment scheduled for 4/20/2018?
4) How many doctors are participating in two currently incomplete studies?
5) What is the least expensive completed/incomplete study?
6) What studies have at least two assigned activities?
7) Which doctors have never had an appointment with “John Doe”?
8) Which doctors have seen at least two patients at an appointment?
9) List sponsors involved in at least 2 completed studies.
10) Which subjects have been involved in a study that has been completed?

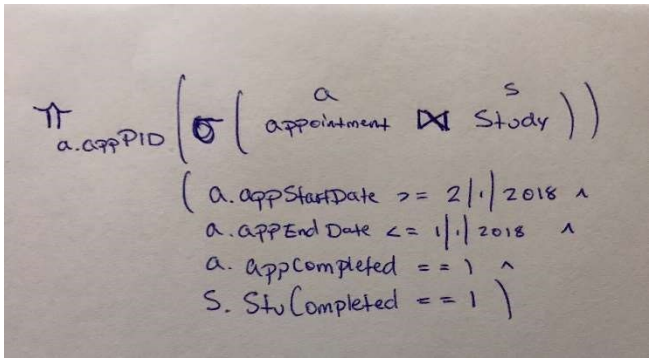
### 2.4.1 Design of Queries

In this section we will answer the queries specified above in Relational Algebra, Tuple Relational Calculus, and Domain Relational Calculus. Each of the languages will be explained beforehand.

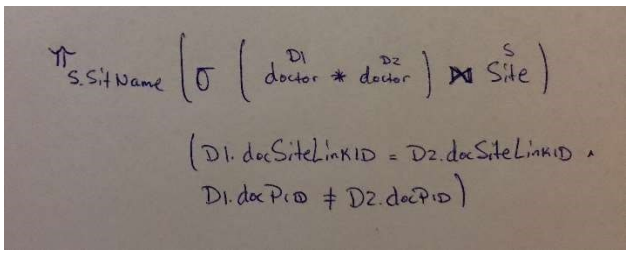
### 2.4.2 Relational Algebra Expressions for Queries

Relational algebra is used to retrieve rows or records from a relational database. Relational algebra is a procedural language, and multiple expressions are combined to answer important and/or complex queries.

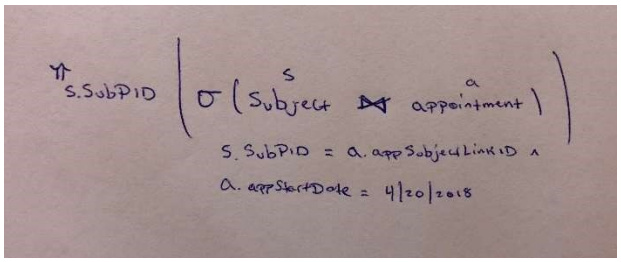
1) How many appointments were completed between 1/1/2018 and 2/1/2018 for currently completed studies?



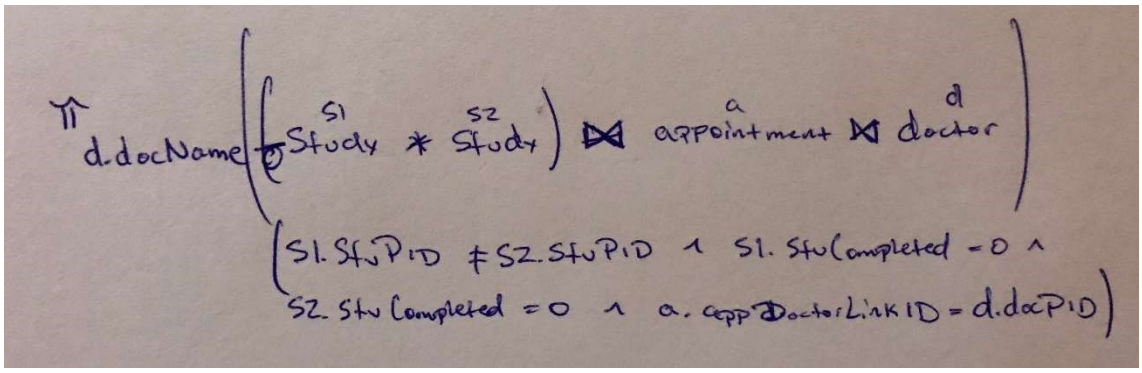

2) How many sites have more than two doctors?



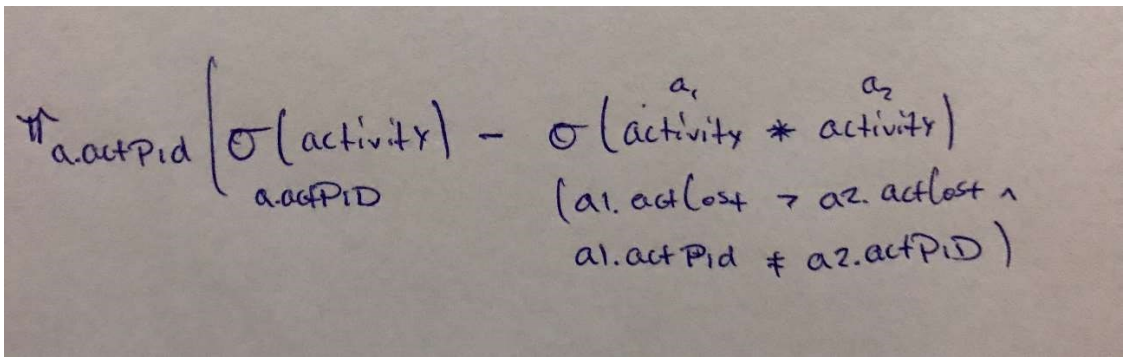

3) How many subjects have an appointment scheduled for 4/20/2018?



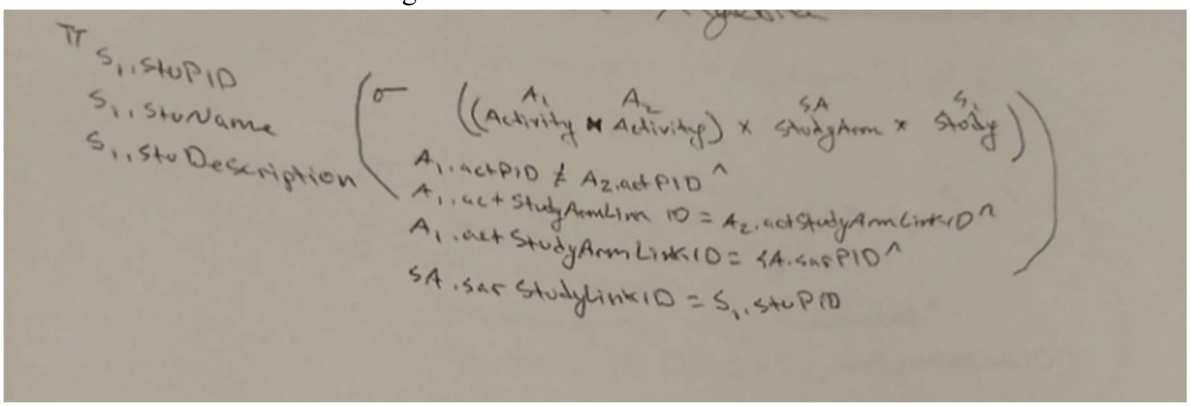

4) How many doctors are participating in two currently incomplete studies?



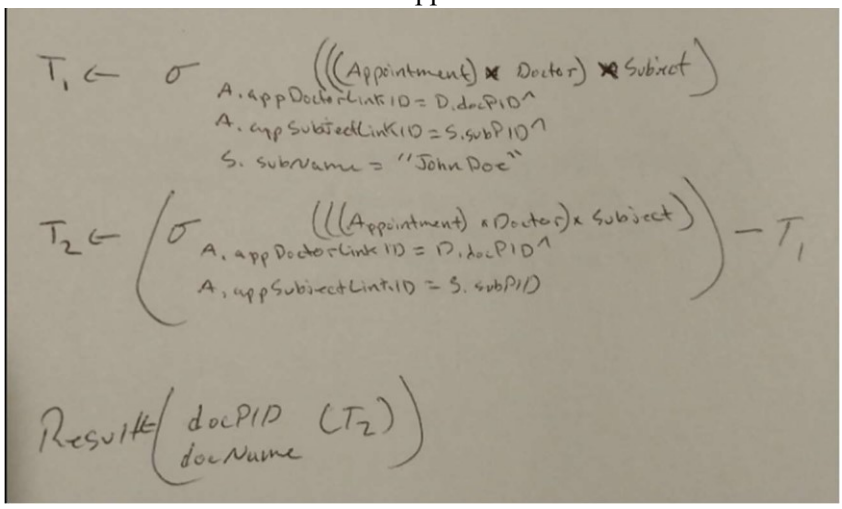

5) What is the least expensive completed/incomplete study?



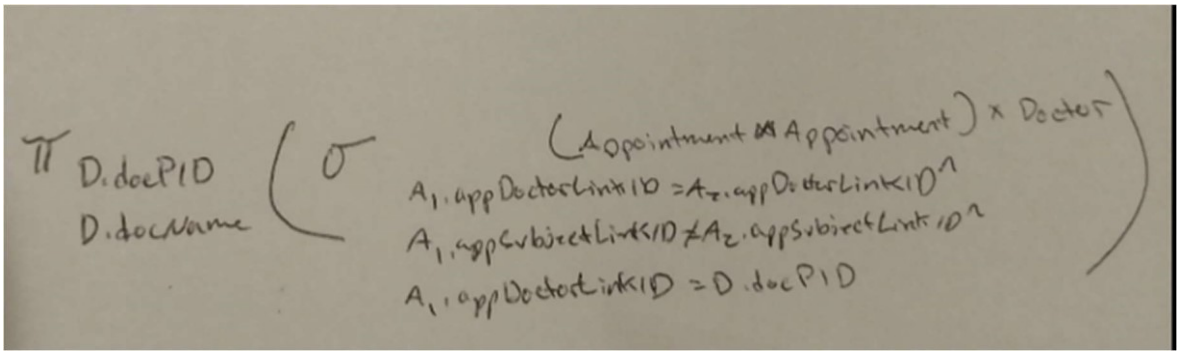

6) What studies have at least two assigned activities?



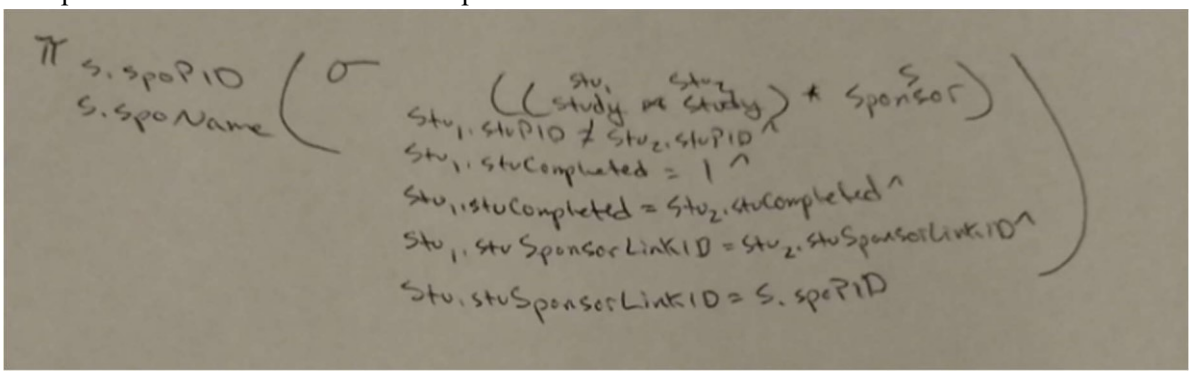

7) Which doctors have never had an appointment with “John Doe”?



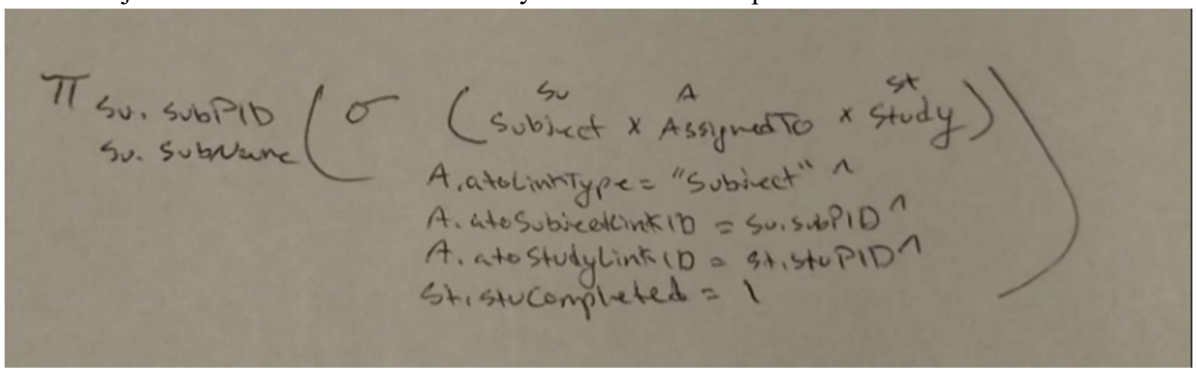

8) Which doctors have seen at least two patients at an appointment?




9) List sponsors involved in at least 2 completed studies.



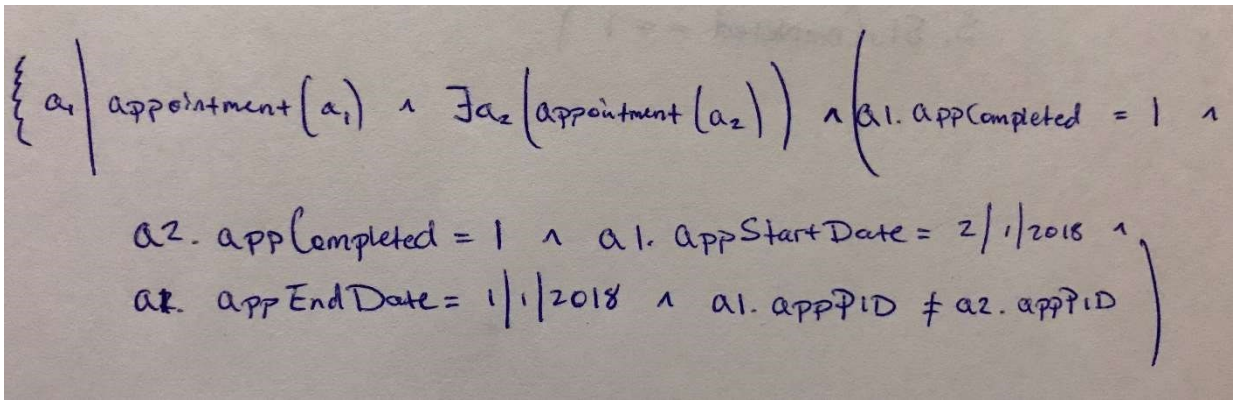

10) Which subjects have been involved in a study that has been completed?



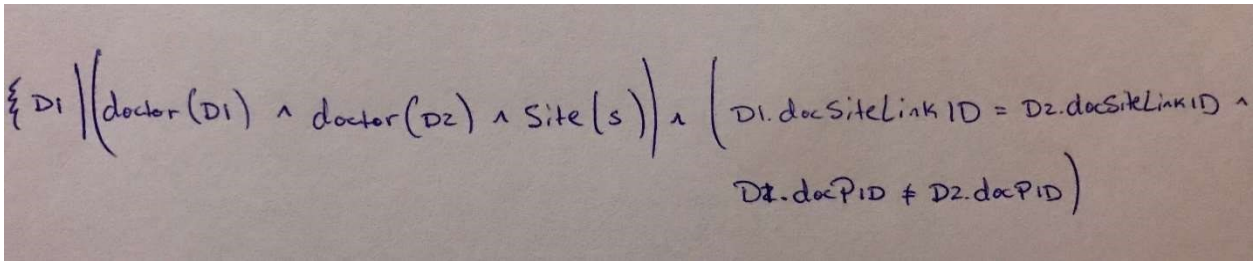
## 2.4.3 Tuple Relational Calculus Expressions for Queries

Relational calculus operations describe the rows or tuples that are retrieved. The expressions are non-procedural, so the order of operations isn't taken into consideration. Free and bound variables are used to extract tuples, which is the data that fits on the specified domain.

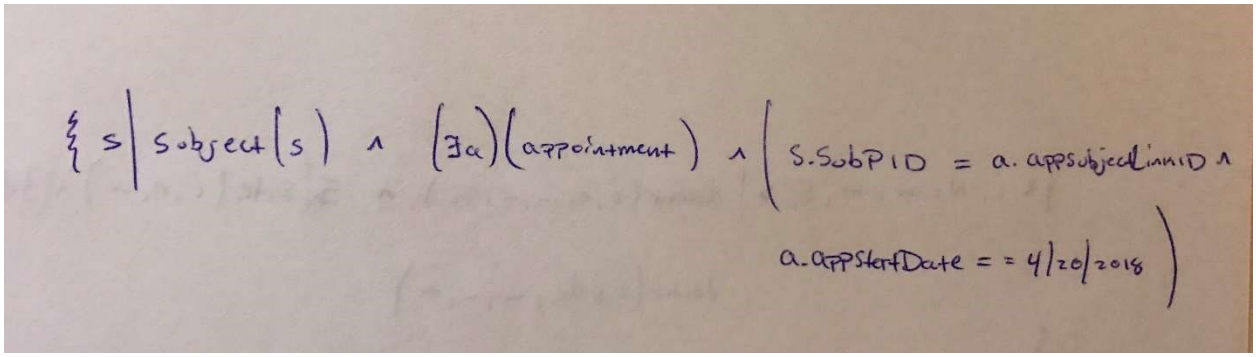
1) How many appointments were completed between 1/1/2018 and 2/1/2018 for currently completed studies?



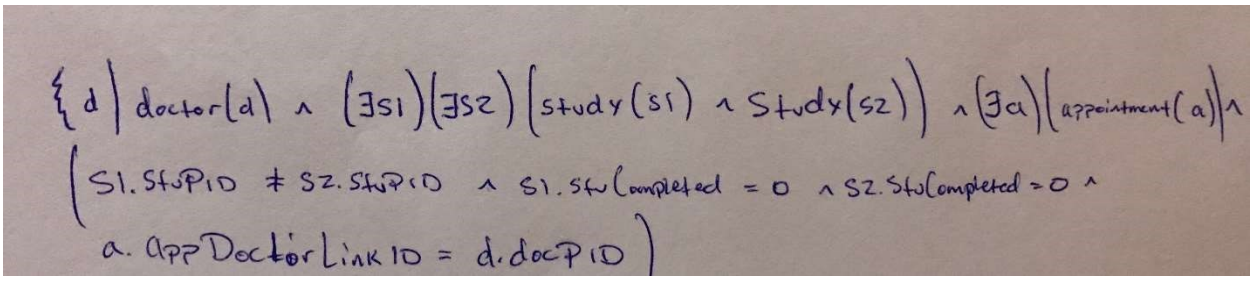

2) How many sites have more than two doctors?



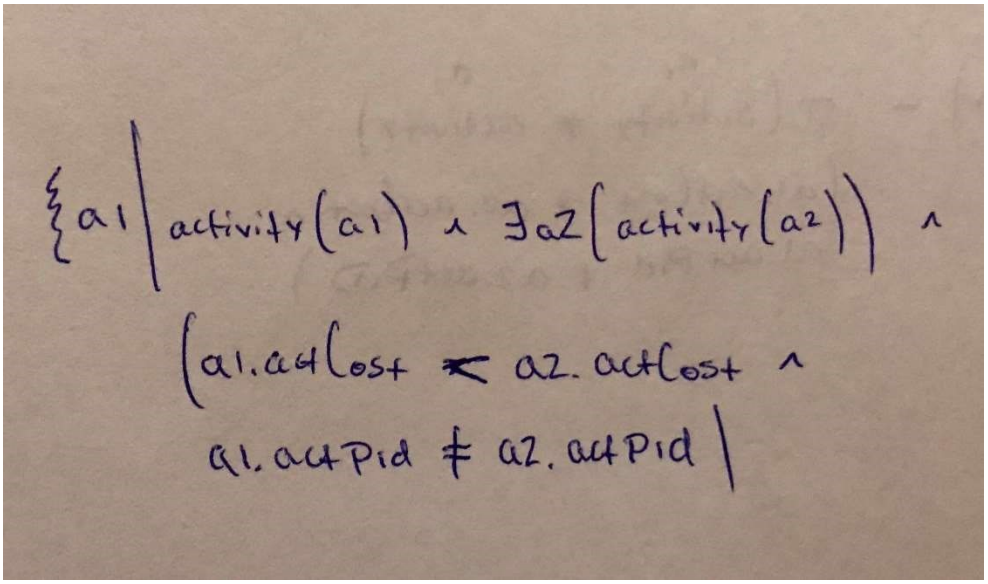

3) How many subjects have an appointment scheduled for 4/20/2018?



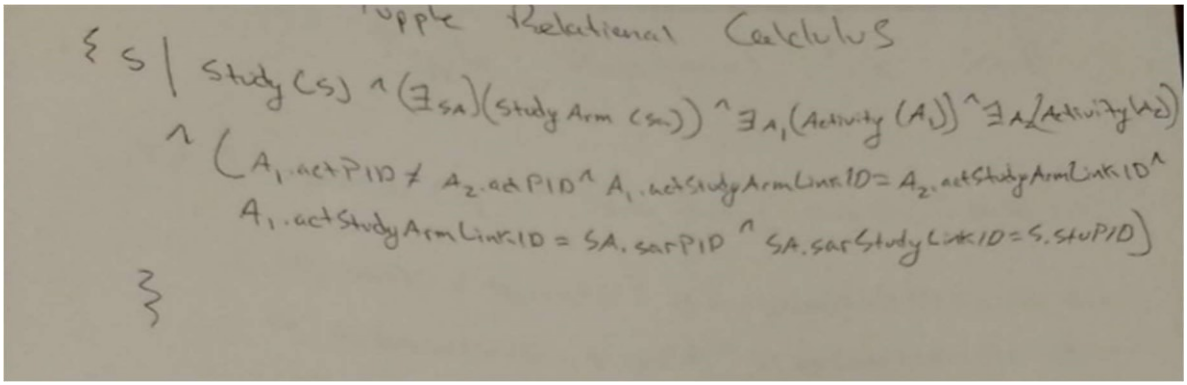
4) How many doctors are participating in two currently incomplete studies?



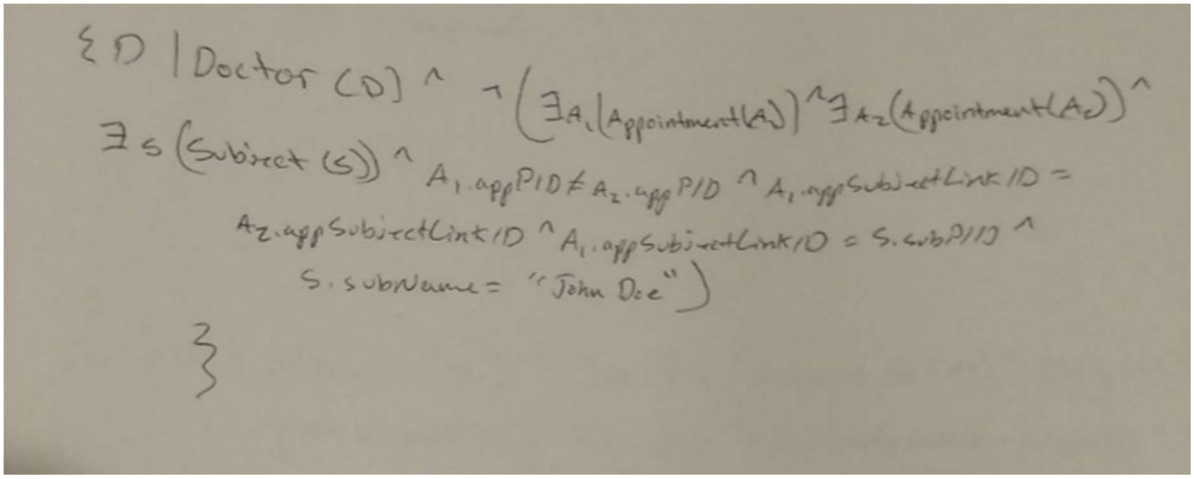

5) What is the least expensive completed/incomplete study?



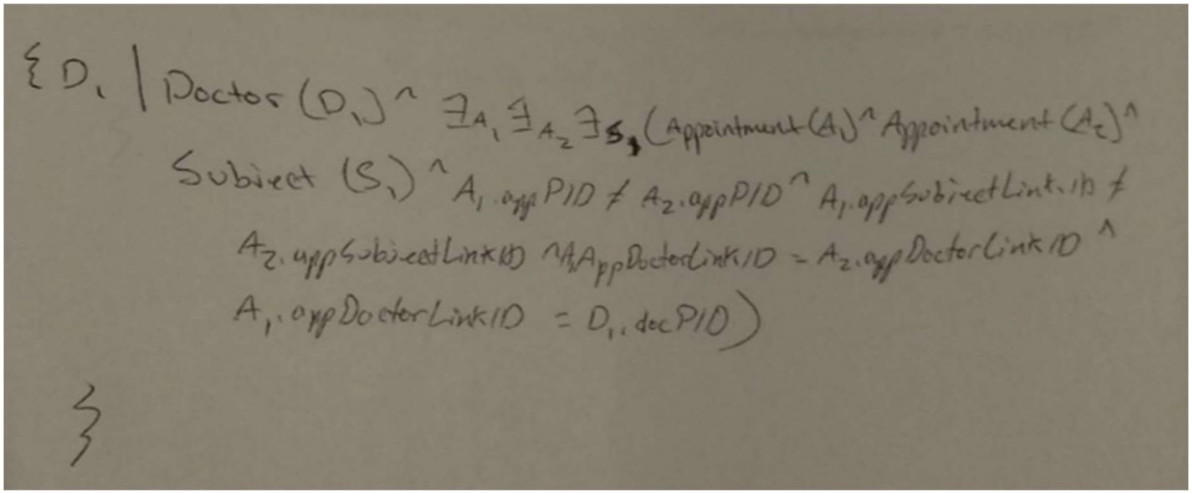

6) What studies have at least two assigned activities?



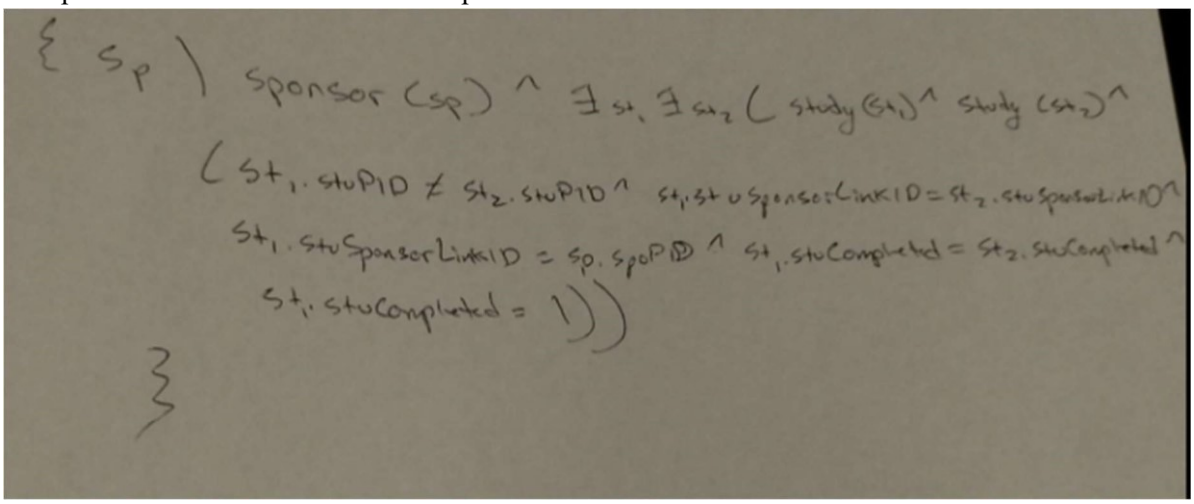

7) Which doctors have never had an appointment with “John Doe”?



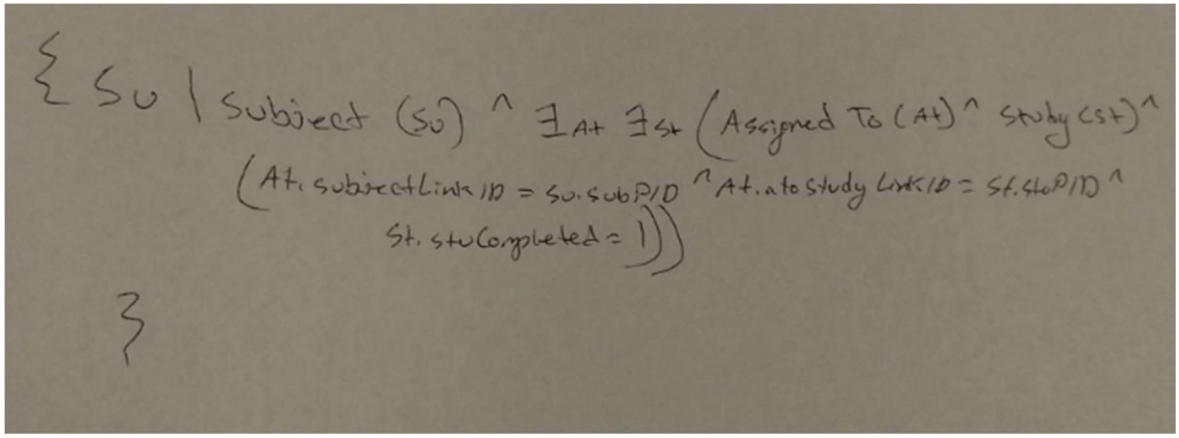

8) Which doctors have seen at least two patients at an appointment?




9) List sponsors involved in at least 2 completed studies.



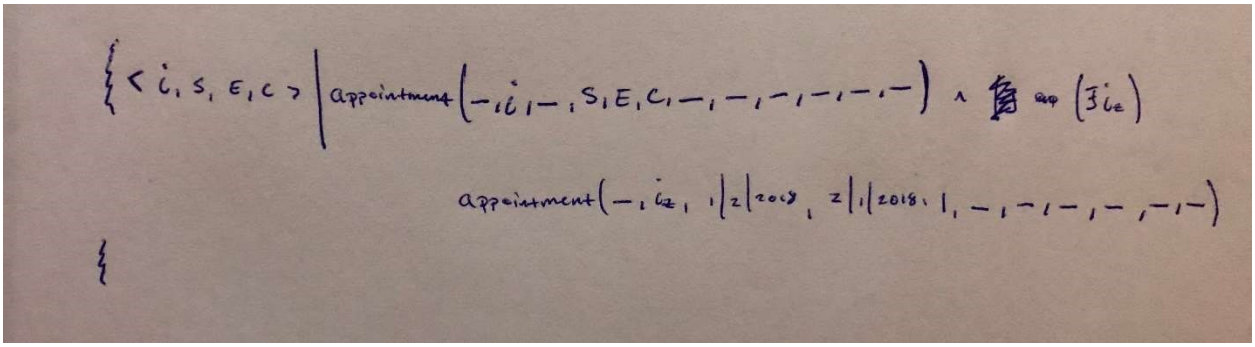

10) Which subjects have been involved in a study that has been completed?


{ Su | Subject (Su) ^ ∃At ∃St (Assigned To (At) ^ Study (St) ^
(At.subjectLinkID = Su.subPID ^ At.atoStudyLinkID = St.stuPID ^
St.stuCompleted = 1))
}

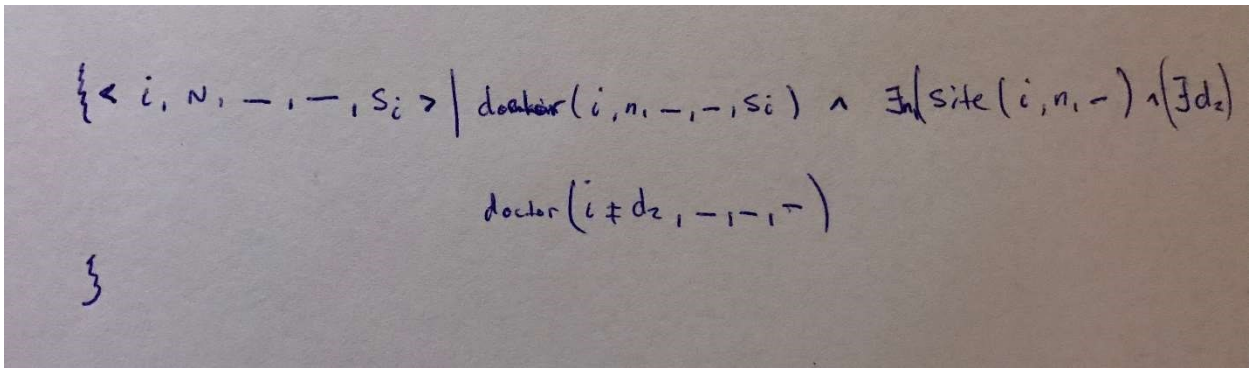
## 2.4.4 Domain Relational Calculus Expressions for Queries

Domain Relational calculus can best be described as a different kind of relational calculus. Variables represent data or values of a tuple (the individual instances of an attribute) as opposed to the entire tuple.

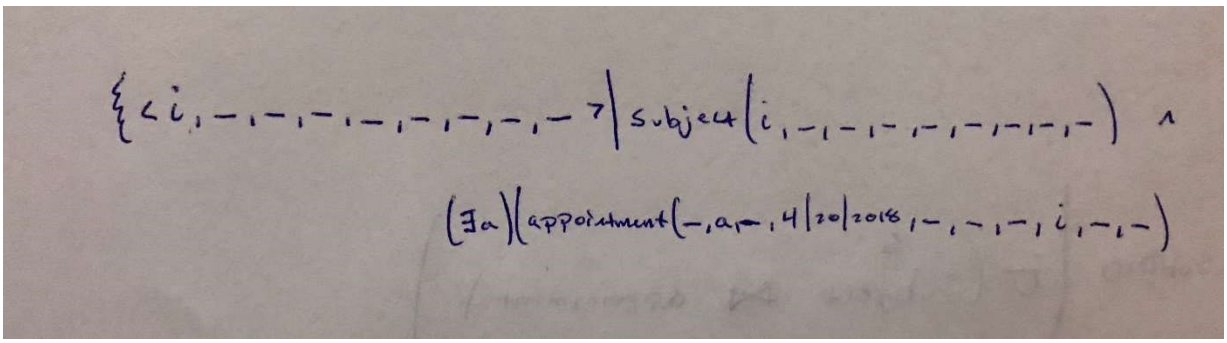
1) How many appointments were completed between 1/1/2018 and 2/1/2018 for currently completed studies?



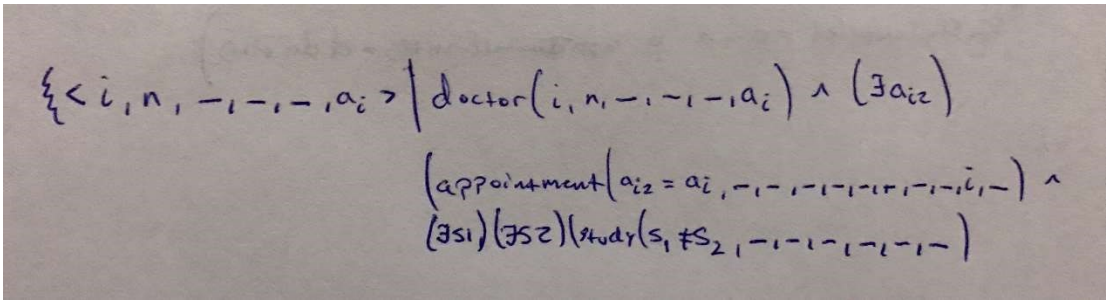
2) How many sites have more than two doctors?



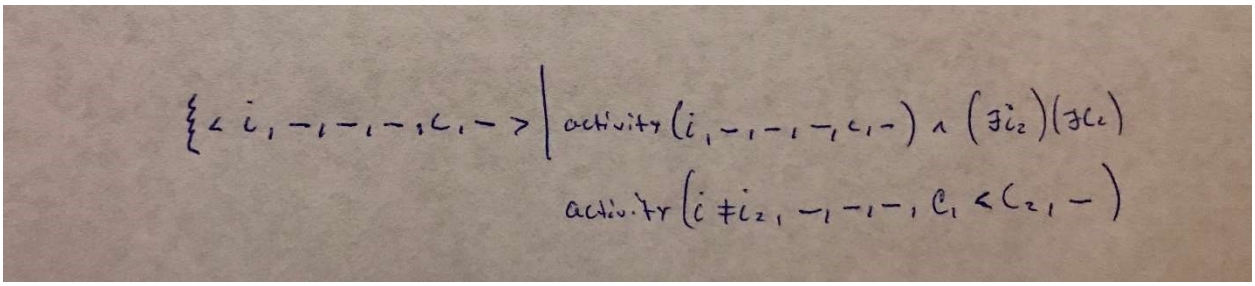
3) How many subjects have an appointment scheduled for 4/20/2018?



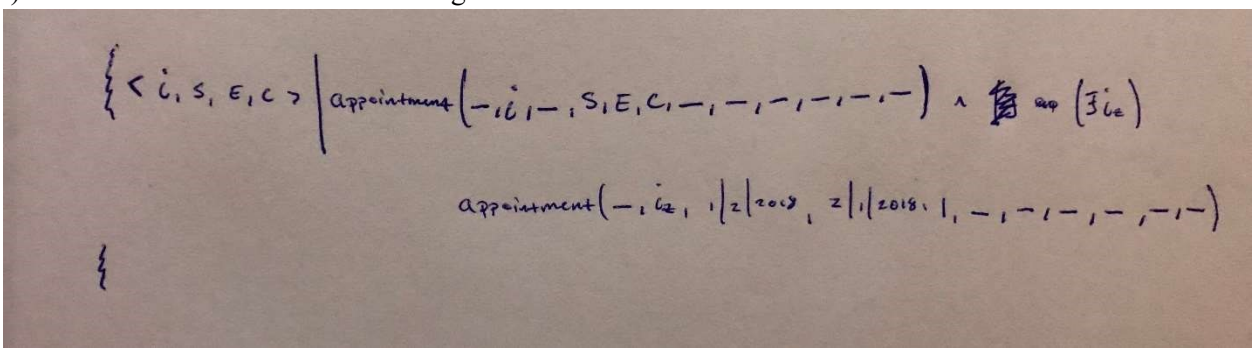
4) How many doctors are participating in two currently incomplete studies?



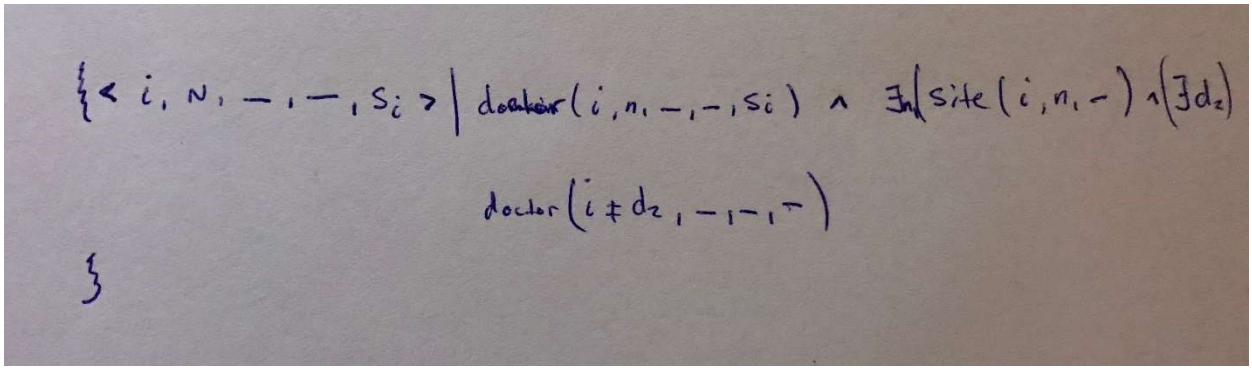
5) What is the least expensive completed/incomplete study?



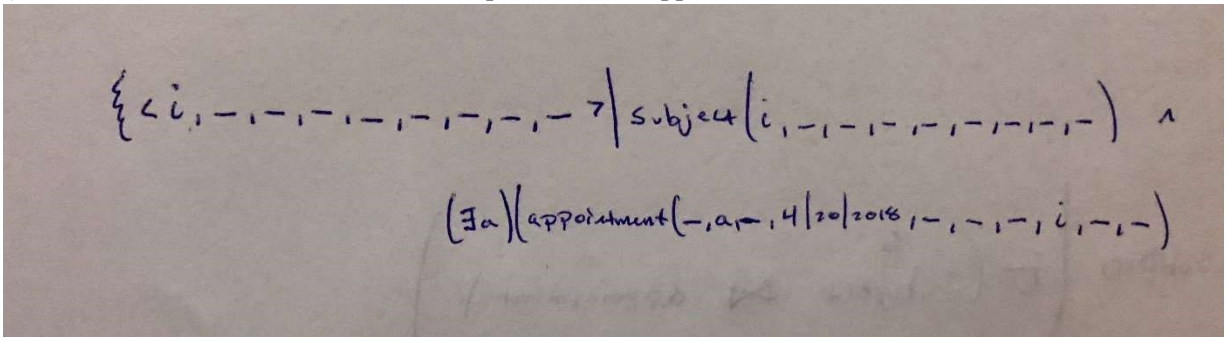
6) What studies have at least two assigned activities?



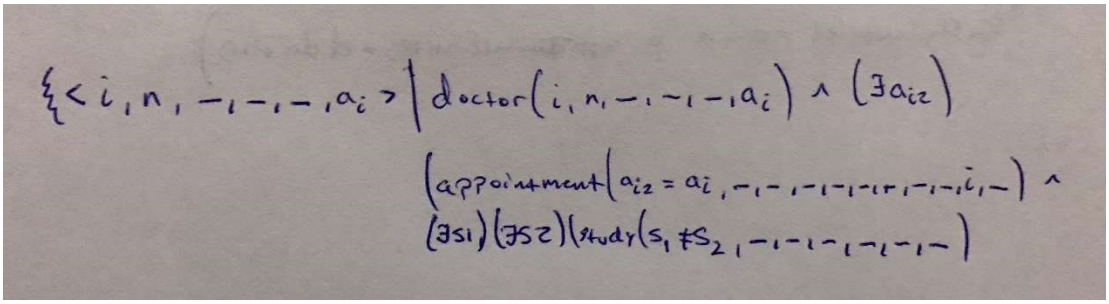
7) Which doctors have never had an appointment with “John Doe”?



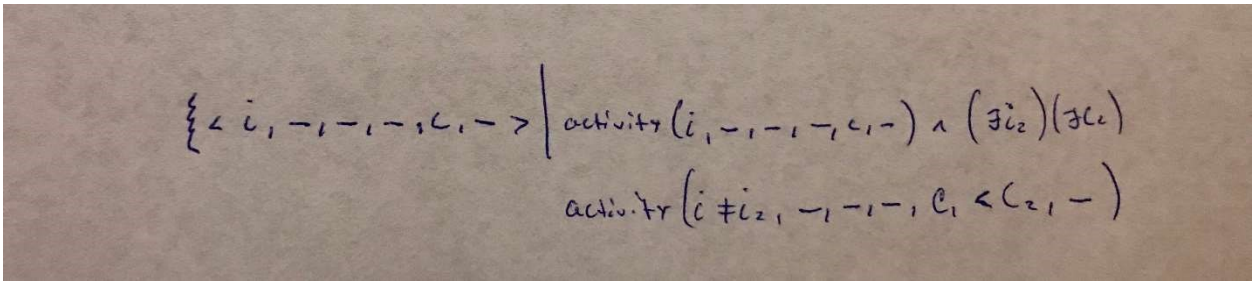
8) Which doctors have seen at least two patients at an appointment?



9) List sponsors involved in at least 2 completed studies.



10) Which subjects have been involved in a study that has been completed?



# 3. SQL Server and SQL Server Management Studio

## 3.1 Normalization of relations

Before we can implement a physical version of our logical database, we must first make sure that the quality of the relational database is adequate. This part of phase three is dedicated to analyzing the quality of our relation database using a method called normalization. This will survey the schema to make sure that it is well designed. This will find potential issues of the design that may occur when applying certain operations to a poorly designed relation database design once the change is made to a logical database.

### 3.1.1 Normalization and Normal Forms

There are certain levels of normalization and this section will cover them. A relational database schema can be designed in such a way that tuples may contain data that is redundant. This will result in inaccurate result and even errors because if that tuple is changed it may also have to be changed in several others for the integrity of the data to remain secure. This is known as a modification anomaly.

Normalization consists of breaking down relation schemas for the sole purpose to eliminate redundancy and these modification anomalies do not happen.

Normal form tests are designed to test relational schemas to make sure they are normalized. Normal form(NF) tests have four levels: first, second, third, and Boyce-Codd. They are also ranked with first being the least desirable and Boyce-Codd being the most desirable. Typically all schemas should fall within the upper half of the spectrum. Next, each level will be described:

First Normal Form

To achieve First Normal Form(1NF) then all attributes in a relation schema must be single and atomic. They must NOT have tuples that have nested tuples of values. To combat this, multi-value attributes are broken down into separate relations that have original primary key as a foreign key attribute. This method was also described previously in Phase two when we covered how to handle multi-value attributes. Other solution to this involve creating new tuples that will have levels to them, creating tuples that will depend on other tuples, this should be avoided because it will ultimately lead to a modification anomaly.

Second Normal Form

To a achieve Second Normal Form(2NF) it must first satisfy 1NF and also, all attributes are have nothing to do with the primary key, must fully functionally depend on that primary key. All other attributes other than the primary key, revolve around that primary key. The concept is simple. A set Y depends on an another set of values X, this is so if and only if X maps to the set of values of Y. In other words, Y depends on X.

This leads to the non-prime attributes to functionally depend on the entire primary key and not just a part of it, not matter how bug the part. If a relation schema has a single attribute primary key, then it automatically passes the 2NF test.

Should a schema fail this test, then it must be broken down into smaller relation schema who have primary keys that are direct subsets of the primary that was originally part of the bigger relation schema.

Third Normal Form

Third Normal Form(3NF) is much simpler than the previous forms. First and foremost, it must satisfy the first two forms and it must also have its non-prime attributes NOT depend on the primary key. In other words, all the attributes in a table are determined only by candidate keys. To solve a failed 3NF test, the schema must be broken down into other relations where the left side of the functional dependency is ALWAYS the primary key attribute.

This completes the first three forms, with one to go. But it is a good place to mention a handy phrase that is spin on another already famous phrase. "… the key, the whole key, and nothing but the key." "The key"(1NF) ensures that it does in fact exist, "the whole key"(2NF) ensures that non-prime attributes depend on the key, and finally "nothing but the key" (3NF) ensures that it is in fact the most important piece of the puzzle.

Boyce-Codd Normal Form

The Boyce-Codd Normal Form(BCNF) requires that all previous forms be satisfied. It is very similar to 3NF but is far more advanced and has a higher standard. It requires that the left side of any functional dependency must be a primary key. In addition to this it does NOT allow any of the prime attributes to depend on non-prime attributes. To mend this issue, it is possible to break down the relation where non-prime attributes located on the left side become prime attributes of a new relational schema. Anomalies from poor Normalization

The upper half of the forms must be satisfied in order to make sure that redundancy does not happen. There are three anomalies that may happen:

Update Anomalies

If there is a join of a set of tuples of a single relation to several other relations, then the vales of the attributes that are part of the single relation will appear in all the tuples after the join. If any of the values are changed in any one tuple than they must be changed for all in order to maintain integrity amongst the data.

Insertion Anomalies

When two relations are joined using natural join and stored into one relation, this creates redundant data. Assuming that the first three forms were compromised. When trying to insert new tuples for the newly relation, anomalies can occur. In order to insert two tuples that both represent two different relations into one single relation, the attribute values must be the same in order for the data to not become corrupted. And when trying to insert a tuple that represents a relation that is NOT joined to any other relations, the attributes of that relation schema must ALL

be set to NULL. And if any if the attributes that help create the primary key of the joined relation are set to NULL, then the integrity constraint is now compromised.

Deletion Anomalies

When a single relation that is represented by a set of tuples is joined to several other relations, and then all of these tuples are removed then any part of the single relation will be removed from the database.

## 3.1.2 Normal Forms for Our Own Database

USER:

FD = Functional Dependency

FD1. Trivial: {stuPID} -> (stuDescription, stuEnrollmentGoal…,stuSiteLinkID)

FD2.{userPID}

Candidate Keys:

-userPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key). SITE:

FD1. Trivial: {sitPID}-> (sitName,

sitDescription) FD2. Trivial: {sitName}-

>(sitPID, sitDescription) Candidate Keys:

sitPID, sitName

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

SPONSOR:

FD1. Trivial: {spoPID}-> (spoName, spoDescription, spoPhoneNumber)

FD2.Trivial: {spoName} -> (spoName, spoDescription,

spoPhoneNumber) Candidate Keys: spoPID, spoName

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

DOCTOR:

FD1. Trivial: {docPID} -> (docName, docSpecialization, docPhoneNumber)

Candidate Keys:

docPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

SUBJECT:

FD1. Trivial: {subject} -> (subPID, subInitials, subGender, subDOB, …, subSurvivalStatus)

Candidate Keys:

subPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

STUDY

FD1. Trivial: {stuPID} -> (stuName, stuDescription, stuEnrollmentGoal, …, stuSiteLinkID)
Candidate Keys:

stuPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

STUDY ARM

FD1. Trivial: {sarPID} -> (sarName, sarDescription, sarStudyLinkID)

Candidate Keys:

sarPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

VISIT

FD1. Trivial: {visPID} -> (visName, visDescription, visStartDate, visEndDate,

visStudyArmLinkID) Candidate Keys:

visPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

ACTIVITY

FD1. Trivial: {actPID} -> (actName, actDescription, actDuration, actCost, actStudyArmLinkID)

Candidate Keys:

actPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

APPOINTMENT

FD1. Trivial: {appPID} -> (appName, appDescription, …, appSubjectLinkID, appDoctorLinkID)

Candidate Keys:

appPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

DOCUMENT INFO

FD1. Trivial: {dinPID} -> (dinDescription, dinFileName, …, dinStudyLinkID)

Candidate Keys:

dinPID

Normal Form Checklist:

1NF is satisfied because all attributes have atomic domains.

2NF is satisfied because the primary key only has one attribute.

3NF is satisfied because no non-prime attributes depend on other non-prime attributes.

BNF is satisfied because the left side of all functional dependencies is a candidate key (SSN is a candidate key).

## 3.3 Schema Objects for SSMS

Tables:

Tables are the bottom layer of data storage in a SQL Database. Tables are composed of a certain kind of schema which includes the column name and a datatype (Varchar, Nvarchar, int, DateTime). After data is inserted it can remain there unchanged forever or be updated or deleted using SQL Update and Delete statements. Additionally, the data can be retrieved with queries using a Select statement. Virtual (or temporary) tables can also be created based upon the schema of existing tables, or be given a unique schema on the fly.

Syntax:

```
--Simple CREATE TABLE Syntax (common if not using options)
CREATE TABLE
    [ database_name . [ schema_name ] . | schema_name . ] table_name
    ( { <column_definition> } [ ,...n ] )
[ ; ]
```

Views:

Views are the output of stored queries which do not in themselves store any real data but rather return the most up to date data already stored. Select statements are used

to join together tables to show whatever data is required. This tool allows a developer or database administrator to control what data is shown and how as opposed to giving the average user access to data he/she may not be allowed to see. Views are most commonly returned to front end applications to show stored that stored data.

Syntax:

```
CREATE VIEW "VIEW_NAME" AS "SQL Statement";
```

OR

Create or Replace View <View_Name> As <Select…>

Stored Procedures:

A stored procedure is just a pre-written section of reusable (and likely frequently used) SQL code that performs an action (Select/Update/Delete). Since stored procedures can be called with triggers they can also be automatically called whenever an event occurs on the data. It's good practice to call stored procedures from a front-end of an application to perform operations as opposed to interacting with the data directly.

Syntax:

```
CREATE [ OR ALTER ] { PROC | PROCEDURE }
    [schema_name.] procedure_name [ ; number ]
    [ { @parameter [ type_schema_name. ] data_type }
        [ VARYING ] [ = default ] [ OUT | OUTPUT | [READONLY]
    ] [ ,...n ]
[ WITH <procedure_option> [ ,...n ] ]
[ FOR REPLICATION ]
AS { [ BEGIN ] sql_statement [;] [ ...n ] [ END ] }
[;]

<procedure_option> ::=
    [ ENCRYPTION ]
    [ RECOMPILE ]
    [ EXECUTE AS Clause ]
```

Triggers:

A trigger is just a pre-written section of SQL that runs each time data is updated, inserted or deleted (as defined). They can also be created on other kinds of events like when a user logs in.

Syntax:

```
CREATE [ OR ALTER ] TRIGGER [ schema_name . ]trigger_name
ON { table | view }
[ WITH <dml_trigger_option> [ ,...n ] ]
{ FOR | AFTER | INSTEAD OF }
{ [ INSERT ] [ , ] [ UPDATE ] [ , ] [ DELETE ] }
[ WITH APPEND ]
[ NOT FOR REPLICATION ]
AS { sql_statement  [ ; ] [ ,...n ] | EXTERNAL NAME <method specifier [ ; ] > }

<dml_trigger_option> ::=
    [ ENCRYPTION ]
    [ EXECUTE AS Clause ]

<method_specifier> ::=
    assembly_name.class_name.method_name
```

Packages:

Packages are collections of objects and stored procedures that encapsulate data and functions for use in front-end applications without giving complete access to the code behind it. There is a “public” interaction with the package as well as the full listing of all functions. Oracle accomplishes this more natively than SQL Server.

Syntax: (Oracle)

Create Package <Package_Name> as <Declarations> end

Sequence Generator:

A sequence object is a schema-bound object that generates a series of values (increasing/decreasing) at predefined intervals. Sequences are not associated with specific tables, but rather a user application can reference a sequence object and use those values across multiple tables. There are also functions (like GET VALUE FOR) that can be used to get sequence information without inserting rows.

Syntax:

```
CREATE SEQUENCE [schema_name . ] sequence_name
    [ AS [ built_in_integer_type | user-defined_integer_type ] ]
    [ START WITH <constant> ]
    [ INCREMENT BY <constant> ]
    [ { MINVALUE [ <constant> ] } | { NO MINVALUE } ]
    [ { MAXVALUE [ <constant> ] } | { NO MAXVALUE } ]
    [ CYCLE | { NO CYCLE } ]
    [ { CACHE [ <constant> ] } | { NO CACHE } ]
    [ ; ]
```

Index:

An index allows queries to be completed much faster than those with reference tables without them. AN index can be based on a unique set of columns or as a single unique column. Indexes can be created/recreated at will and do not affect the data inside the table being referenced.

Syntax:

```
CREATE [ UNIQUE ] [ CLUSTERED | NONCLUSTERED ] INDEX index_name
    ON <object> ( column [ ASC | DESC ] [ ,...n ] )
    [ INCLUDE ( column_name [ ,...n ] ) ]
    [ WHERE <filter_predicate> ]
    [ WITH ( <relational_index_option> [ ,...n ] ) ]
    [ ON { partition_scheme_name ( column_name )
         | filegroup_name
         | default
         }
    ]
    [ FILESTREAM_ON { filestream_filegroup_name | partition_scheme_name | "NULL" } ]

[ ; ]

<object> ::=
{
    [ database_name. [ schema_name ] . | schema_name. ]
    table_or_view_name
}
```

## 3.4.1 List Relations with SQL commands

### Site:

```
exec sp_columns [Site]
```

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | Site | sitPID | 4 | int | 10 | 4 | 0 |
| 2 | DB_91387_spring2018db | dbo | Site | sitName | 12 | varchar | 50 | 50 | NULL |
| 3 | DB_91387_spring2018db | dbo | Site | sitDescription | 12 | varchar | 50 | 50 | NULL |

```
select * from [Site]
```

| sitPID | sitName | sitDescription |
|---|---|---|
| 1 | First Site | Primary |
| 2 | Second Site | Secondary |
| 3 | Third Site | Third |
| 4 | Fourth Site | Fourth |
| 5 | Fifth Site | Fifth |
| 6 | Sixth Site | Sixth |
| 7 | Seventh Site | Seventh |
| 8 | Eighth Site | Eighth |
| 9 | Ninth Site | Ninth |
| 10 | Tenth Site | Tenth |

### Sponsor:

```
exec sp_columns Sponsor
```

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | Sponsor | spoPID | 4 | int | 10 | 4 | 0 |
| 2 | DB_91387_spring2018db | dbo | Sponsor | spoName | 12 | varchar | 50 | 50 | NULL |
| 3 | DB_91387_spring2018db | dbo | Sponsor | spoPhoneNumber | 12 | varchar | 25 | 25 | NULL |

```
select * from Sponsor
```

| spoPID | spoName | spoPhoneNumber |
|---|---|---|
| 1 | First Sponsor | 128394857 |
| 2 | Second Sponsor | 1948475596 |
| 3 | Third Sponsor | 3886604857 |
| 4 | Fourth Sponsor | 2959688473 |
| 5 | Fifth Sponsor | 1992939945 |
| 6 | Sixth Sponsor | 2999394055 |
| 7 | Seventh Sponsor | 1002004956 |
| 8 | Eighth Sponsor | 1002030054 |
| 9 | Ninth Sponsor | 1002030056 |
| 10 | Tenth Sponsor | 1002035783 |

### Doctor:

```
exec sp_columns Doctor
```

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | Doctor | docPID | 4 | int | 10 | 4 | 0 |
| 2 | DB_91387_spring2018db | dbo | Doctor | docName | 12 | varchar | 100 | 100 | NULL |
| 3 | DB_91387_spring2018db | dbo | Doctor | docSpecialization | 12 | varchar | 50 | 50 | NULL |
| 4 | DB_91387_spring2018db | dbo | Doctor | docPhoneNumber | 12 | varchar | 25 | 25 | NULL |

```
select * from Doctor
```

| docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|
| 1 | First Doctor | Vision | 1234984102 |
| 2 | Second Doctor | Olfactory | 129472178 |
| 3 | Third Doctor | Research | 1027384957 |
| 4 | Fourth Doctor | Research | 1029992716 |
| 5 | Fifth Doctor | Vision | 7738291826 |
| 6 | Sixth Doctor | Cancer | 1029783821 |
| 7 | Seventh Doctor | Cardiovascular | 1002838477 |
| 8 | Eighth Doctor | Psychology | 1022283371 |
| 9 | Ninth Doctor | Family Psychology | 8566377459 |
| 10 | Tenth Doctor | Research | 1002884772 |

## Study:

```
exec sp_columns Study
```

Results Messages

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE | RADIX | NULLABLE | REMARKS | COLUMN_D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | Study | stuPID | 4 | int | 10 | 4 | 0 | 10 | 1 | NULL | NULL |
| 2 | DB_91387_spring2018db | dbo | Study | stuName | 12 | varchar | 50 | 50 | NULL | NULL | 1 | NULL | NULL |
| 3 | DB_91387_spring2018db | dbo | Study | stuDescription | 12 | varchar | 75 | 75 | NULL | NULL | 1 | NULL | NULL |
| 4 | DB_91387_spring2018db | dbo | Study | stuEnrollmentGoal | 4 | int | 10 | 4 | 0 | 10 | 1 | NULL | NULL |
| 5 | DB_91387_spring2018db | dbo | Study | stuSponsorLinkID | 4 | int | 10 | 4 | 0 | 10 | 1 | NULL | NULL |
| 6 | DB_91387_spring2018db | dbo | Study | stuSiteLinkID | 4 | int | 10 | 4 | 0 | 10 | 1 | NULL | NULL |

```
select * from Study
```

| | stuPID | stuName | stuDescription | stuEnrollmentGoal | stuSponsorLinkID | stuSiteLinkID |
|---|---|---|---|---|---|---|
| 1 | 1 | First Study | Primary | 25 | 1 | 4 |
| 2 | 2 | Second Study | Second | 50 | 4 | 2 |
| 3 | 3 | Third Study | Third | 100 | 3 | 8 |
| 4 | 4 | Fourth Study | Fourth | 20 | 4 | 4 |
| 5 | 5 | Fifth Study | Fifth | 10 | 5 | 5 |
| 6 | 6 | Sixth Study | Sixth | 10 | 6 | 7 |
| 7 | 7 | Seventh Study | Seventh | 15 | 7 | 8 |
| 8 | 8 | Eigth Study | Eigth | 20 | 7 | 2 |
| 9 | 9 | Ninth Study | Ninth | 50 | 5 | 6 |
| 10 | 10 | Tenth Study | Tenth | 100 | 4 | 9 |

## StudyArm:

```
exec sp_columns StudyArm
```

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | StudyArm | sarPID | 4 | int | 10 | 4 | 0 |
| 2 | DB_91387_spring2018db | dbo | StudyArm | sarName | 12 | varchar | 50 | 50 | NULL |
| 3 | DB_91387_spring2018db | dbo | StudyArm | sarDescription | 12 | varchar | 75 | 75 | NULL |
| 4 | DB_91387_spring2018db | dbo | StudyArm | sarStudyLinkID | 4 | int | 10 | 4 | 0 |

```
select * from StudyArm
```

| sarPID | sarName | sarDescription | sarStudyLinkID |
|---|---|---|---|
| 1 | First Arm | Primary | 1 |
| 2 | Second Arm | Secondary | 1 |
| 3 | First Arm | Primary | 2 |
| 4 | Second Arm | Secondary | 2 |
| 5 | First Arm | Primary | 3 |
| 6 | Second Arm | Secondary | 3 |
| 7 | First Arm | Primary | 4 |
| 8 | Second Arm | Secondary | 4 |
| 9 | First Arm | Primary | 5 |
| 10 | Second Arm | Secondary | 5 |
| 11 | First Arm | Primary | 6 |
| 12 | Second Arm | Secondary | 6 |
| 13 | First Arm | Primary | 7 |
| 14 | Second Arm | Secondary | 7 |
| 15 | First Arm | Primary | 8 |
| 16 | Second Arm | Secondary | 8 |
| 17 | First Arm | Primary | 9 |
| 18 | Second Arm | Secondary | 9 |
| 19 | First Arm | Primary | 10 |
| 20 | Second Arm | Secondary | 10 |

# Activity:

```
exec sp_columns Activity
```

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | Activity | actPID | 4 | int | 10 | 4 | 0 |
| 2 | DB_91387_spring2018db | dbo | Activity | actName | 12 | varchar | 50 | 50 | NULL |
| 3 | DB_91387_spring2018db | dbo | Activity | actDescription | 12 | varchar | 75 | 75 | NULL |
| 4 | DB_91387_spring2018db | dbo | Activity | actDuration | 4 | int | 10 | 4 | 0 |
| 5 | DB_91387_spring2018db | dbo | Activity | actCost | 6 | float | 15 | 8 | NULL |
| 6 | DB_91387_spring2018db | dbo | Activity | actStudyArmLinkID | 4 | int | 10 | 4 | 0 |

```
select * from Activity
```

| actPID | actName | actDescription | actDuration | actCost | actStudyArmLinkID |
|---|---|---|---|---|---|
| 1 | First Activity | First | 60 | 95 | 1 |
| 2 | Second Activity | Second | 60 | 100 | 1 |
| 3 | Third Activity | Third | 60 | 39.99 | 1 |
| 4 | First Activity | First | 60 | 60 | 2 |
| 5 | Second Activity | Second | 60 | 75 | 2 |
| 6 | Third Activity | Third | 60 | 150 | 2 |
| 7 | First Activity | First | 60 | 95 | 3 |
| 8 | Second Activity | Second | 60 | 100 | 3 |
| 9 | Third Activity | Third | 60 | 39.99 | 3 |
| 10 | First Activity | First | 60 | 60 | 4 |
| 11 | Second Activity | Second | 60 | 75 | 4 |
| 12 | Third Activity | Third | 60 | 150 | 4 |
| 13 | First Activity | First | 60 | 95 | 5 |
| 14 | Second Activity | Second | 60 | 100 | 5 |
| 15 | Third Activity | Third | 60 | 39.99 | 5 |
| 16 | First Activity | First | 60 | 60 | 6 |
| 17 | Second Activity | Second | 60 | 75 | 6 |
| 18 | Third Activity | Third | 60 | 150 | 6 |
| 19 | First Activity | First | 60 | 95 | 7 |
| 20 | Second Activity | Second | 60 | 100 | 7 |
| 21 | Third Activity | Third | 60 | 39.99 | 7 |
| 22 | First Activity | First | 60 | 60 | 8 |
| 23 | Second Activity | Second | 60 | 75 | 8 |
| 24 | Third Activity | Third | 60 | 150 | 8 |
| 25 | First Activity | First | 60 | 95 | 9 |
| 26 | Second Activity | Second | 60 | 100 | 9 |
| 27 | Third Activity | Third | 60 | 39.99 | 9 |
| 28 | First Activity | First | 60 | 60 | 10 |

## Visit:

```
exec sp_columns Visit
```

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | Visit | visPID | 4 | int | 10 | 4 | 0 |
| 2 | DB_91387_spring2018db | dbo | Visit | visName | 12 | varchar | 50 | 50 | NULL |
| 3 | DB_91387_spring2018db | dbo | Visit | visDescription | 12 | varchar | 75 | 75 | NULL |
| 4 | DB_91387_spring2018db | dbo | Visit | visStart | 11 | datetime | 23 | 16 | 3 |
| 5 | DB_91387_spring2018db | dbo | Visit | visEnd | 11 | datetime | 23 | 16 | 3 |
| 6 | DB_91387_spring2018db | dbo | Visit | visStudyArmLinkID | 4 | int | 10 | 4 | 0 |

```
select * from Visit
```

| visPID | visName | visDescription | visStart | visEnd | visStudyArmLinkID |
|---|---|---|---|---|---|
| 1 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 |
| 2 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 |
| 3 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 |
| 4 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 |
| 5 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 |
| 6 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 |
| 7 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 3 |
| 8 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 3 |
| 9 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 3 |
| 10 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 4 |
| 11 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 4 |
| 12 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 4 |
| 13 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 5 |
| 14 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 5 |
| 15 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 5 |
| 16 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 6 |
| 17 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 6 |
| 18 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 6 |
| 19 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 7 |
| 20 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 7 |
| 21 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 7 |
| 22 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 8 |
| 23 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 8 |
| 24 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 8 |
| 25 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 9 |
| 26 | Second Visit | Second | 2018-05-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 9 |
| 27 | Third Visit | Third | 2018-05-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 9 |
| 28 | First Visit | First | 2018-05-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 10 |

# Appointment:

```
exec sp_columns Appointmnet
```

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | Appointment | appPID | 4 | int | 10 | 4 | 0 |
| 2 | DB_91387_spring2018db | dbo | Appointment | appStartTime | 11 | datetime | 23 | 16 | 3 |
| 3 | DB_91387_spring2018db | dbo | Appointment | appEndTime | 11 | datetime | 23 | 16 | 3 |
| 4 | DB_91387_spring2018db | dbo | Appointment | appCompleted | 4 | int | 10 | 4 | 0 |
| 5 | DB_91387_spring2018db | dbo | Appointment | appStudyArmLinkID | 4 | int | 10 | 4 | 0 |
| 6 | DB_91387_spring2018db | dbo | Appointment | appActivityLinkID | 4 | int | 10 | 4 | 0 |
| 7 | DB_91387_spring2018db | dbo | Appointment | appVisitLinkID | 4 | int | 10 | 4 | 0 |
| 8 | DB_91387_spring2018db | dbo | Appointment | appSubjectLinkID | 4 | int | 10 | 4 | 0 |
| 9 | DB_91387_spring2018db | dbo | Appointment | appDoctorLinkID | 4 | int | 10 | 4 | 0 |

```
select * from Appointment
```

| appPID | appStartTime | appEndTime | appCompleted | appStudyArmLinkID | appActivityLinkID | appVisitLinkID | appSubjectLinkID | appDoctorLinkID |
|---|---|---|---|---|---|---|---|---|
| 1 | 2018-05-01 12:00:00.000 | 2018-05-01 13:00:00.000 | 0 | 1 | 3 | 1 | 1 | 1 |
| 1 | 2018-05-01 12:00:00.000 | 2018-05-01 13:00:00.000 | 0 | 1 | 2 | 2 | 1 | 1 |
| 1 | 2018-05-01 12:00:00.000 | 2018-05-01 13:00:00.000 | 0 | 1 | 1 | 3 | 1 | 1 |
| 1 | 2018-05-01 12:00:00.000 | 2018-05-01 13:00:00.000 | 0 | 2 | 4 | 6 | 2 | 2 |
| 1 | 2018-05-01 12:00:00.000 | 2018-05-01 13:00:00.000 | 0 | 2 | 5 | 5 | 3 | 2 |
| 1 | 2018-05-01 12:00:00.000 | 2018-05-01 13:00:00.000 | 0 | 2 | 6 | 4 | 3 | 2 |
| 1 | 2018-04-01 12:00:00.000 | 2018-04-01 13:00:00.000 | 1 | 3 | 7 | 9 | 4 | 1 |
| 1 | 2018-04-01 12:00:00.000 | 2018-04-01 13:00:00.000 | 1 | 3 | 8 | 8 | 4 | 1 |
| 1 | 2018-04-01 12:00:00.000 | 2018-04-01 13:00:00.000 | 1 | 3 | 9 | 7 | 4 | 1 |
| 1 | 2018-04-01 12:00:00.000 | 2018-04-01 13:00:00.000 | 1 | 4 | 11 | 11 | 5 | 3 |
| 1 | 2018-04-01 12:00:00.000 | 2018-04-01 13:00:00.000 | 1 | 4 | 10 | 10 | 5 | 3 |
| 1 | 2018-04-01 12:00:00.000 | 2018-04-01 13:00:00.000 | 1 | 4 | 12 | 12 | 6 | 3 |
| 1 | 2018-03-01 12:00:00.000 | 1900-01-01 00:00:00.000 | 0 | 5 | 13 | 14 | 7 | 4 |
| 1 | 2018-03-01 12:00:00.000 | 2018-03-01 13:00:00.000 | 1 | 5 | 14 | 13 | 7 | 4 |
| 1 | 2018-03-01 12:00:00.000 | 2018-03-01 13:00:00.000 | 1 | 5 | 15 | 14 | 8 | 5 |
| 1 | 2018-03-01 12:00:00.000 | 2018-03-01 13:00:00.000 | 1 | 4 | 17 | 16 | 9 | 6 |
| 1 | 2018-03-01 12:00:00.000 | 2018-03-01 13:00:00.000 | 1 | 4 | 18 | 17 | 9 | 7 |
| 1 | 2018-03-01 12:00:00.000 | 2018-03-01 13:00:00.000 | 1 | 4 | 16 | 18 | 9 | 8 |

# DocumentInfo:

```
exec sp_columns DocumentInfo
```

| | TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DB_91387_spring2018db | dbo | DocumentInfo | dinPID | 4 | int | 10 | 4 | 0 |
| 2 | DB_91387_spring2018db | dbo | DocumentInfo | dinDescription | 12 | varchar | 75 | 75 | NULL |
| 3 | DB_91387_spring2018db | dbo | DocumentInfo | dinFileName | -1 | text | 2147483647 | 2147483647 | NULL |
| 4 | DB_91387_spring2018db | dbo | DocumentInfo | dinBLOB | -1 | text | 2147483647 | 2147483647 | NULL |
| 5 | DB_91387_spring2018db | dbo | DocumentInfo | dinVersion | 4 | int | 10 | 4 | 0 |
| 6 | DB_91387_spring2018db | dbo | DocumentInfo | dinStudyLinkID | 4 | int | 10 | 4 | 0 |

```
select * from DocumentInfo
```

| dinPID | dinDescription | dinFileName | dinBLOB | dinVersion | dinStudyLinkID |
|---|---|---|---|---|---|
| 1 | Patient History | somefilename.pdf | 0x0001e240 | 2 | 1 |
| 2 | Notes | notes.txt | 0x0001e240 | 6 | 1 |
| 3 | Regulatory | regdocs.pdf | 0x0001e240 | 2 | 1 |
| 4 | Release of Liability | rol.pdf | 0x0001e240 | 2 | 1 |
| 5 | Patient History | somefilename.pdf | 0x0001e240 | 2 | 2 |
| 6 | Notes | notes.txt | 0x0001e240 | 6 | 2 |
| 7 | Regulatory | regdocs.pdf | 0x0001e240 | 2 | 2 |
| 8 | Release of Liability | rol.pdf | 0x0001e240 | 2 | 2 |
| 9 | Patient History | somefilename.pdf | 0x0001e240 | 2 | 3 |
| 10 | Notes | notes.txt | 0x0001e240 | 6 | 3 |
| 11 | Regulatory | regdocs.pdf | 0x0001e240 | 2 | 3 |
| 12 | Release of Liability | rol.pdf | 0x0001e240 | 2 | 3 |
| 13 | Patient History | somefilename.pdf | 0x0001e240 | 2 | 4 |
| 14 | Notes | notes.txt | 0x0001e240 | 6 | 4 |
| 15 | Regulatory | regdocs.pdf | 0x0001e240 | 2 | 4 |
| 16 | Release of Liability | rol.pdf | 0x0001e240 | 2 | 4 |
| 17 | Patient History | somefilename.pdf | 0x0001e240 | 2 | 5 |
| 18 | Notes | notes.txt | 0x0001e240 | 6 | 5 |
| 19 | Regulatory | regdocs.pdf | 0x0001e240 | 2 | 5 |
| 20 | Release of Liability | rol.pdf | 0x0001e240 | 2 | 5 |
| 21 | Patient History | somefilename.pdf | 0x0001e240 | 2 | 6 |
| 22 | Notes | notes.txt | 0x0001e240 | 6 | 6 |
| 23 | Regulatory | regdocs.pdf | 0x0001e240 | 2 | 6 |
| 24 | Release of Liability | rol.pdf | 0x0001e240 | 2 | 6 |
| 25 | Patient History | somefilename.pdf | 0x0001e240 | 2 | 7 |
| 26 | Notes | notes.txt | 0x0001e240 | 6 | 7 |
| 27 | Regulatory | regdocs.pdf | 0x0001e240 | 2 | 7 |
| 28 | Release of Liability | rol.pdf | 0x0001e240 | 2 | 7 |
| 29 | Patient History | somefilename.pdf | 0x0001e240 | 2 | 8 |
| 30 | Notes | notes.txt | 0x0001e240 | 6 | 8 |

# AssignedTo:

```
exec sp_columns AssignedTo
```

| TABLE_QUALIFIER | TABLE_OWNER | TABLE_NAME | COLUMN_NAME | DATA_TYPE | TYPE_NAME | PRECISION | LENGTH | SCALE |
|---|---|---|---|---|---|---|---|---|
| DB_91387_spring2018db | dbo | AssignedTo | atoPID | 4 | int | 10 | 4 | 0 |
| DB_91387_spring2018db | dbo | AssignedTo | atoStartDate | 11 | datetime | 23 | 16 | 3 |
| DB_91387_spring2018db | dbo | AssignedTo | atoEndDate | 11 | datetime | 23 | 16 | 3 |
| DB_91387_spring2018db | dbo | AssignedTo | atoLinkType | 4 | int | 10 | 4 | 0 |
| DB_91387_spring2018db | dbo | AssignedTo | atoSubjectLinkID | 4 | int | 10 | 4 | 0 |
| DB_91387_spring2018db | dbo | AssignedTo | atoDoctorLinkID | 4 | int | 10 | 4 | 0 |
| DB_91387_spring2018db | dbo | AssignedTo | atoStudyLinkID | 4 | int | 10 | 4 | 0 |

```
select * from AssignedTo
```

| atoPID | atoStartDate | atoEndDate | atoLinkType | atoSubjectLinkID | atoDoctorLinkID | atoStudyLinkID |
|---|---|---|---|---|---|---|
| 1 | 2018-01-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 1 | NULL | 1 |
| 2 | 2018-01-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 2 | NULL | 1 |
| 3 | 2018-01-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 3 | NULL | 2 |
| 4 | 2018-01-04 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 4 | NULL | 2 |
| 5 | 2018-01-05 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 5 | NULL | 3 |
| 6 | 2018-01-06 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 6 | NULL | 3 |
| 7 | 2018-01-07 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 7 | NULL | 4 |
| 8 | 2018-01-08 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 8 | NULL | 4 |
| 9 | 2018-01-09 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 9 | NULL | 5 |
| 10 | 2018-01-10 00:00:00.000 | 1900-01-01 00:00:00.000 | 1 | 10 | NULL | 5 |
| 11 | 2018-01-01 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 1 | 1 |
| 12 | 2018-01-02 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 2 | 1 |
| 13 | 2018-01-03 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 3 | 2 |
| 14 | 2018-01-04 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 4 | 2 |
| 15 | 2018-01-05 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 5 | 3 |
| 16 | 2018-01-06 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 6 | 3 |
| 17 | 2018-01-07 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 7 | 4 |
| 18 | 2018-01-08 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 8 | 4 |
| 19 | 2018-01-09 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 9 | 5 |
| 20 | 2018-01-10 00:00:00.000 | 1900-01-01 00:00:00.000 | 2 | NULL | 10 | 5 |

## 3.4.2 Example Queries in SQL

These are extra queries designed to provide useful information to the front end application:

Query #1:

```
-- Query 1
-- List subjects and their completed activities in 2018 before April 1st

select su.subPID, su.subInitals, ap.appEndTime, ac.actName, ac.actDuration, ac.actCost from Appointment as ap
                    inner join Activity ac on ac.actPID = ap.appActivityLinkID
inner join Subject su on su.subPID = ap.appSubjectLinkID where ap.appEndTime >= '2018-01-01'
                    and ap.appEndTIme < '2018-04-01'
```

Result:

Results | Messages

| | subPID | subInitals | appEndTime | actName | actDuration | actCost |
|---|---|---|---|---|---|---|
| 1 | 7 | PO | 2018-03-01 13:00:00.000 | Second Activity | 60 | 100 |
| 2 | 8 | MN | 2018-03-01 13:00:00.000 | Third Activity | 60 | 39.99 |
| 3 | 9 | CO | 2018-03-01 13:00:00.000 | First Activity | 60 | 60 |
| 4 | 9 | CO | 2018-03-01 13:00:00.000 | Second Activity | 60 | 75 |
| 5 | 9 | CO | 2018-03-01 13:00:00.000 | Third Activity | 60 | 150 |

Query executed successfully. tcp:s

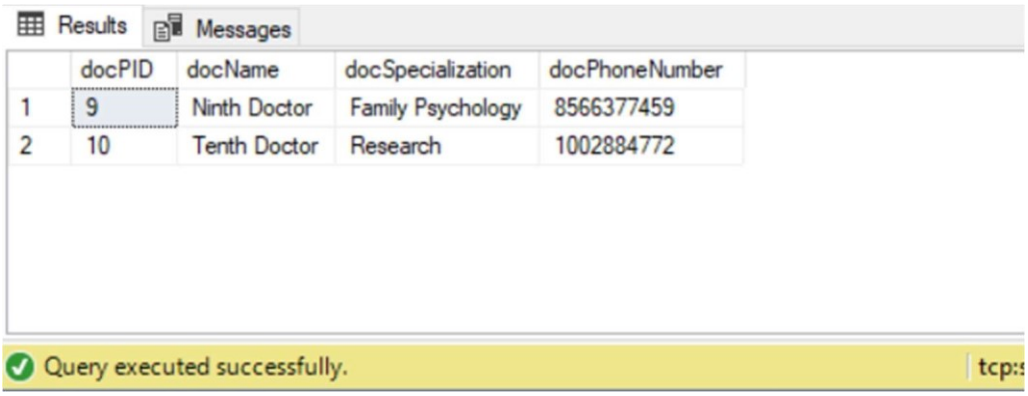
## Query #2:

```
-- Query 2
-- List Doctors not involved in any Appointmnets

select d.docPID, d.docName, d.docSpecialization, d.docPhoneNumber  from Doctor as d

where not exists(select * from Appointment where appDoctorLinkID = d.docPID)
```

Result:



Results | Messages

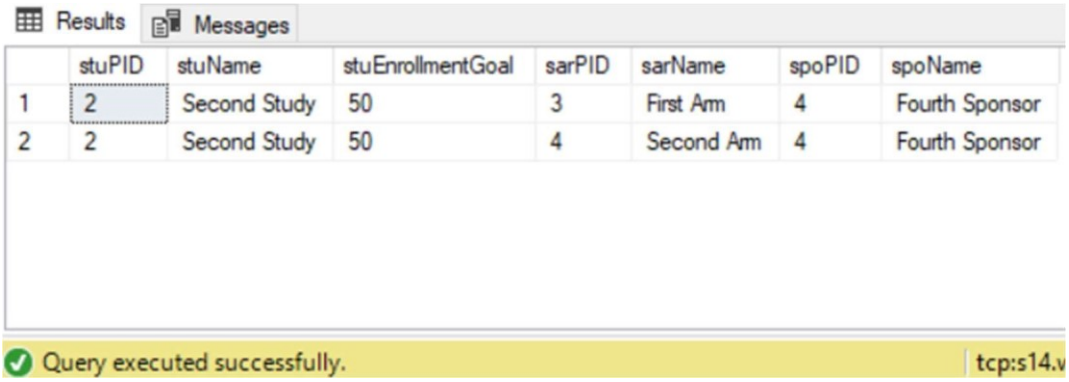
| | docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|---|
| 1 | 9 | Ninth Doctor | Family Psychology | 8566377459 |
| 2 | 10 | Tenth Doctor | Research | 1002884772 |

Query executed successfully. tcp:s

Query #3:

```
-- Query 3
-- List all Studies and their Sponsor that have at least 3 completed Appointmnets
 select s.stuPID, s.stuName, s.stuEnrollmentGoal, sa.sarPID, sa.sarName, sp.spoPID, sp.spoName  from Study as s
                    inner join StudyArm as sa on sa.sarStudyLinkID = s.stuPID                    inner join Sponsor as sp on sp.spoPID = s.stuSponsorLinkID where exists (select                appStudyArmLinkID, count(*) as CompletedAppointmentsByStudy
                                        from Appointment
   where appCompleted = 1 and appStudyArmLinkID = sa.sarPID       group by appStudyArmLinkID       having count(*) >= 3)
```

Result:



Results | Messages

| | stuPID | stuName | stuEnrollmentGoal | sarPID | sarName | spoPID | spoName |
|---|---|---|---|---|---|---|---|
| 1 | 2 | Second Study | 50 | 3 | First Arm | 4 | Fourth Sponsor |
| 2 | 2 | Second Study | 50 | 4 | Second Arm | 4 | Fourth Sponsor |

Query executed successfully. tcp:s14.v

# 4. Oracle Database Management System PL/SQL Components

## 4.1 Oracle PL/SQL

As stated before, we are using the Oracle PL/SQL DBMS, instead we are using Visual Studio along with SQL Server Management Studio. Despite this, they are very similar, and share the same structure, but for the sake of consistency the following will be in MySQL.

Just as in PL/SQL we will be using stored procedures to hide complex sections of code from the user. A stored procedure can be thought of as a function that, when called upon, will perform a particular task. We will also cover triggers which, as the name implies, will only be executed on a particular event occurrence.

### 4.1.1 Stored Procedures

In this section we will highlight three separate stored procedures that will perform a deletion, an insertion, and also one for …

**Deletion:**

```
CREATE PROC DeleteDoctor (@docPID int) AS
DELETE from Doctor
WHERE docPID = @docPID


exec DeleteDoctor 21
```

**Insertion:**

```
ALTER PROC InsertDoctor(@docName varchar(10), @docSpecialization varchar(10), @docPhoneNumber
bigint) AS

	insert [Doctor] (docName, docSpecialization, docPhoneNumber)
	values(@docName, @docSpecialization, @docPhoneNumber)

exec InsertDoctor "Dr Strange", "Brain Guy", 6618084134
```

**Update:**

```
CREATE PROC UpdateDoctor(@docPID int, @docName varchar(100)) AS
	update Doctor
	set docName = @docName
	where docPID = @docPID
exec UpdateDoctor 23, "Hugo Strange"
```

### 4.1.2 Triggers

This section will be dedicated to the triggers. We will demonstrate three triggers. They are as follows: Deletion

**Deletion:**

```
CREATE TRIGGER [dbo].[trig_DeleteAppointments]
       ON [dbo].[Doctor]
       FOR DELETE
AS
       DELETE FROM Appointment
       WHERE appDoctorLinkID IN(SELECT deleted.docPID FROM deleted)
GO

ALTER TABLE [dbo].[Doctor] DISABLE TRIGGER [trig_DeleteAppointments]
GO
```

### 4.1.3 Putting Our Triggers and Stored Procedures into Packages

Instead of putting all of our Triggers and Stored Procedure into packages we put them into a script that can be executed, and it will not only populate all information but also create the entire database. In the following section we will cover what is a package and what the syntax for it is.

## 4.2 Postgres PL/pgSQL

This section will include definitions of stored procedures/functions, triggers, and packages. It will also compare other DMBS systems that to the one we are using for our project. And finally it will include some screenshots of our stored procedures and functions.

In PL/pgSQL a stored procedure is a set of procedural statements that are stored within the database. These statements can be invoked from the interface. In our case we are using MS Visual Studio and SQL Server Management Studio so our procedures and triggers will be in that format. They are very similar and do not differ very much from the others.

**Stored Procedure:** As defined above, a stored procedure is a set of procedural statements that may be invoked from the interface. The syntax for the creation of one is as follows:

CREATE {or ALTER} PROC *name_of_procedure* AS
SELECT *name_of_items_wanted*
FROM *name_of_table*

WHERE *condition_if_needed*

**Stored Function:** A stored function is very similar to a stored procedure. The difference is that a function will return. The reason behind this is because the function will calculate a value and return the value, without having to modify the data within the database.

CREATE {or ALTER} PROC *name_of_procedure* AS

SELECT *name of items wanted*
FROM *name of table*
WHERE *condition if needed*

RETURN *value to be returned*

**Packages:** In terms of MySQL, there is no equivalent for packages. Due to this, we will demonstrate a packages in the syntax of PL/pgSQL. A package is a combination of stored procedures, stored functions, types, and other objects into one unit. The package will contain all the prototypes of the all that is included. In the body, the definitions of all these are included. Here is some sample syntax:

CREATE {or REPLACE} PACKAGE *name of package* AS
    *all that is wanted within the package*
END

CREATE {or REPLACE} PACKAGE body *name of package* AS
    *all that is wanted within the package*
END

**Triggers:** A trigger is simply a stored procedure that is "trigger" or engaged in response to a certain action. These can be activated before, during, or after the event has happened. They may even happen instead of an event that was suppose to take place. Here is some sample syntax:

Example 1:
CREATE TRIGGER *name of trigger* BEFORE INSERT ON *columns name*
FOR EACH ROW *trigger body, what we want it to do*

Example 2:

CREATE TRIGGER *name of trigger* BEFORE INSERT ON *columns name*
FOR EACH ROW *trigger body, what we want it to do*
BEGIN *this could also be used to add more function to trigger*

END

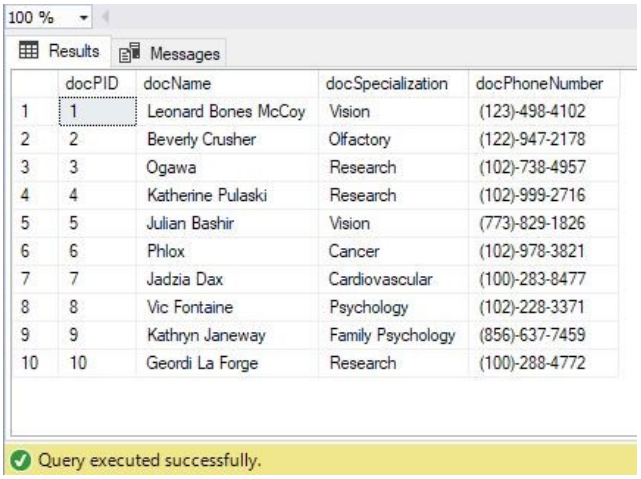
It is also important to note that where INSERT is seen, it can be replaced with UPDATE or DELETE. Where BEFORE can be seen, it can be replaced with AFTER. This is all done with respect to what we want to accomplish.

## 4.3 Postgres/pgSQL Subprograms

In this section we will demonstrate the three stored procedures/functions and also the three triggers. The code will come from section 4.1. Here we will simply display the results of what that code does when it is executed in our database.

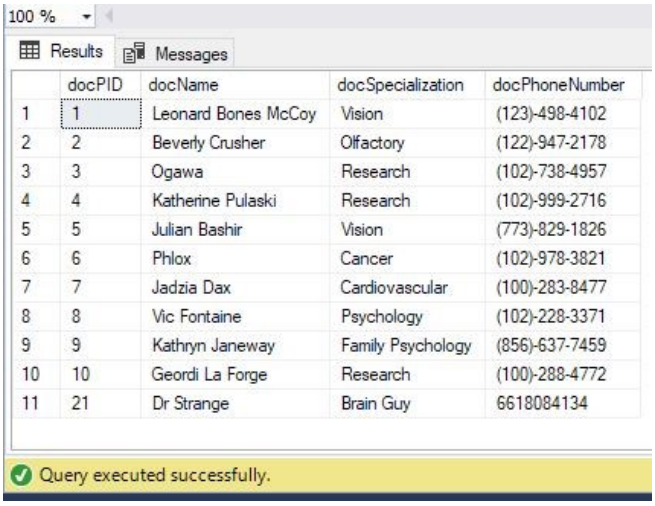
**InsertDoctorProc:** As can be seen below, this is the table Doctor before I call the Insert procedure.

Before:




| | docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|---|
| 1 | 1 | Leonard Bones McCoy | Vision | (123)-498-4102 |
| 2 | 2 | Beverly Crusher | Olfactory | (122)-947-2178 |
| 3 | 3 | Ogawa | Research | (102)-738-4957 |
| 4 | 4 | Katherine Pulaski | Research | (102)-999-2716 |
| 5 | 5 | Julian Bashir | Vision | (773)-829-1826 |
| 6 | 6 | Phlox | Cancer | (102)-978-3821 |
| 7 | 7 | Jadzia Dax | Cardiovascular | (100)-283-8477 |
| 8 | 8 | Vic Fontaine | Psychology | (102)-228-3371 |
| 9 | 9 | Kathryn Janeway | Family Psychology | (856)-637-7459 |
| 10 | 10 | Geordi La Forge | Research | (100)-288-4772 |

After:



100 %

Results | Messages

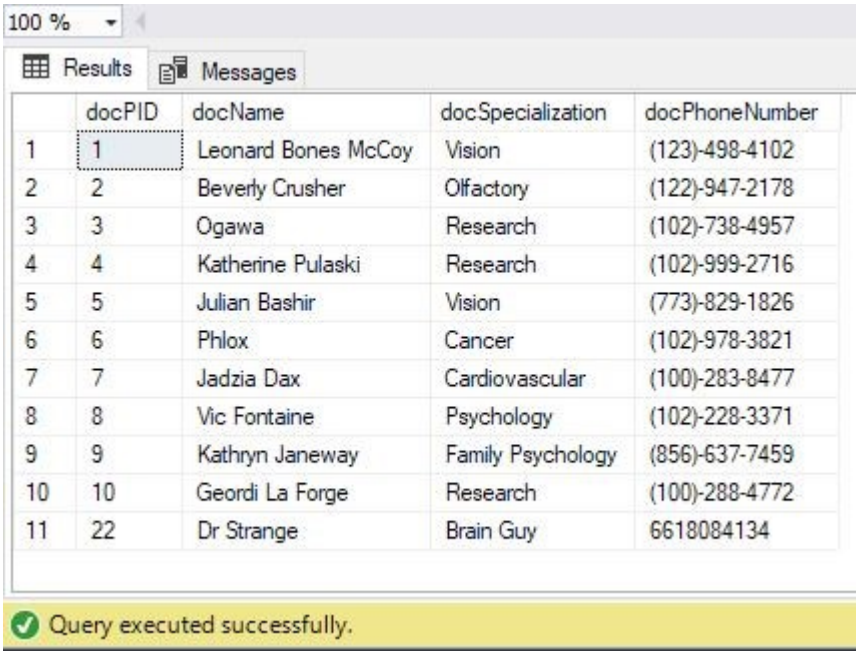
| | docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|---|
| 1 | 1 | Leonard Bones McCoy | Vision | (123)-498-4102 |
| 2 | 2 | Beverly Crusher | Olfactory | (122)-947-2178 |
| 3 | 3 | Ogawa | Research | (102)-738-4957 |
| 4 | 4 | Katherine Pulaski | Research | (102)-999-2716 |
| 5 | 5 | Julian Bashir | Vision | (773)-829-1826 |
| 6 | 6 | Phlox | Cancer | (102)-978-3821 |
| 7 | 7 | Jadzia Dax | Cardiovascular | (100)-283-8477 |
| 8 | 8 | Vic Fontaine | Psychology | (102)-228-3371 |
| 9 | 9 | Kathryn Janeway | Family Psychology | (856)-637-7459 |
| 10 | 10 | Geordi La Forge | Research | (100)-288-4772 |
| 11 | 21 | Dr Strange | Brain Guy | 6618084134 |

Query executed successfully.

As can be seen the result of the call to the procedure result in the addition of Dr Strange.

**DeleteDoctorProc:** The following will be the result of removing a doctor from the table.

Before:



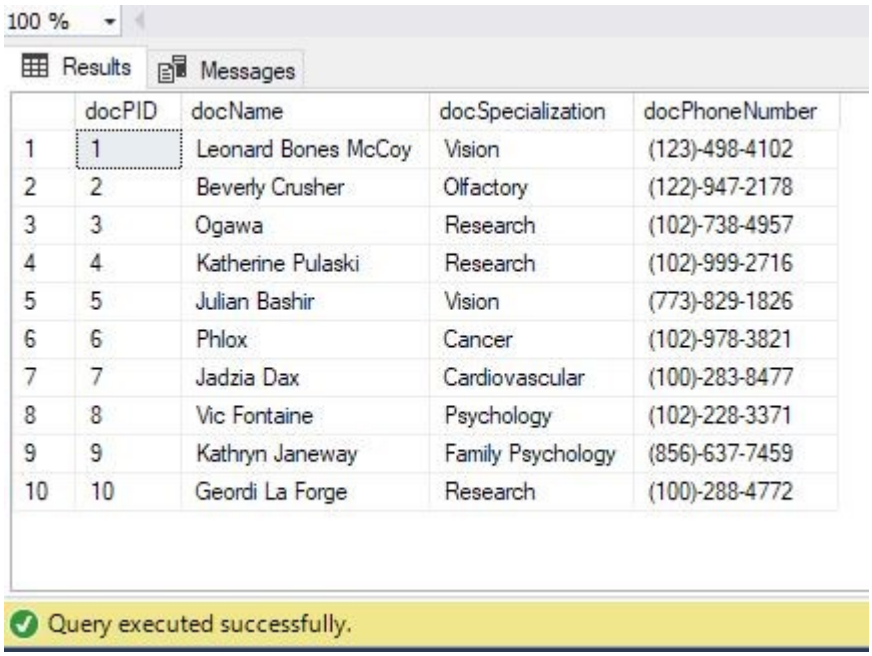
100 %

Results | Messages

| | docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|---|
| 1 | 1 | Leonard Bones McCoy | Vision | (123)-498-4102 |
| 2 | 2 | Beverly Crusher | Olfactory | (122)-947-2178 |
| 3 | 3 | Ogawa | Research | (102)-738-4957 |
| 4 | 4 | Katherine Pulaski | Research | (102)-999-2716 |
| 5 | 5 | Julian Bashir | Vision | (773)-829-1826 |
| 6 | 6 | Phlox | Cancer | (102)-978-3821 |
| 7 | 7 | Jadzia Dax | Cardiovascular | (100)-283-8477 |
| 8 | 8 | Vic Fontaine | Psychology | (102)-228-3371 |
| 9 | 9 | Kathryn Janeway | Family Psychology | (856)-637-7459 |
| 10 | 10 | Geordi La Forge | Research | (100)-288-4772 |
| 11 | 22 | Dr Strange | Brain Guy | 6618084134 |

Query executed successfully.

After:



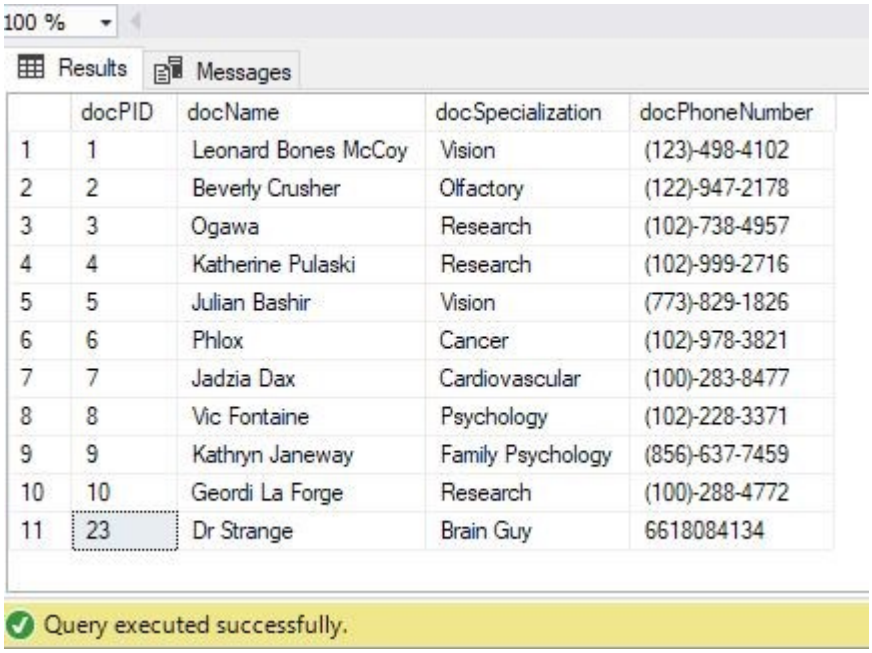
| | docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|---|
| 1 | 1 | Leonard Bones McCoy | Vision | (123)-498-4102 |
| 2 | 2 | Beverly Crusher | Olfactory | (122)-947-2178 |
| 3 | 3 | Ogawa | Research | (102)-738-4957 |
| 4 | 4 | Katherine Pulaski | Research | (102)-999-2716 |
| 5 | 5 | Julian Bashir | Vision | (773)-829-1826 |
| 6 | 6 | Phlox | Cancer | (102)-978-3821 |
| 7 | 7 | Jadzia Dax | Cardiovascular | (100)-283-8477 |
| 8 | 8 | Vic Fontaine | Psychology | (102)-228-3371 |
| 9 | 9 | Kathryn Janeway | Family Psychology | (856)-637-7459 |
| 10 | 10 | Geordi La Forge | Research | (100)-288-4772 |

Query executed successfully.

As can be seen, Dr Strange is no longer part of the table.

**UpdateDoctorProc:** To demonstrate this UPDATE procedure, I will already have Dr Strange in the table and I will change his name to Hugo Strange.

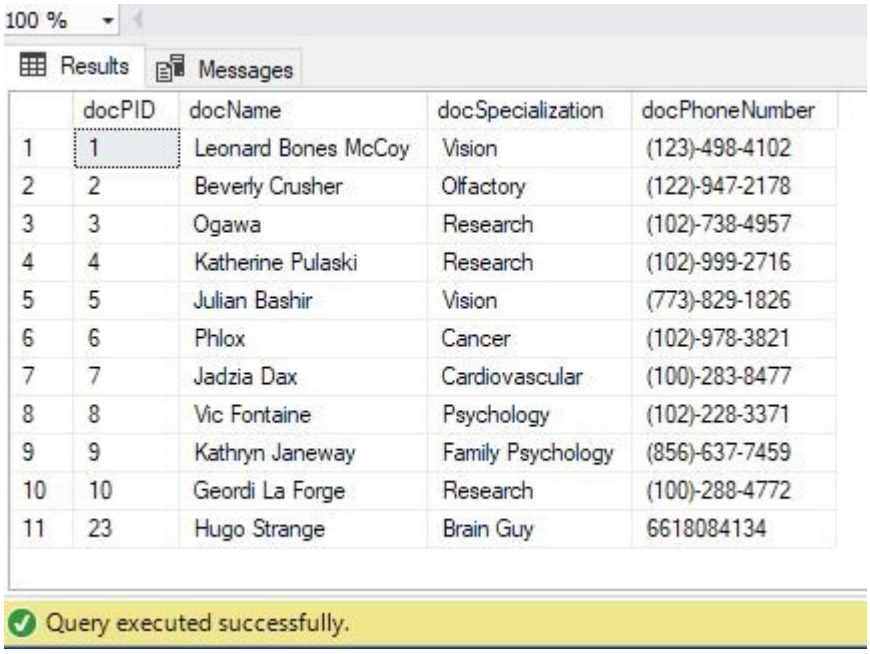
Before:



| | docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|---|
| 1 | 1 | Leonard Bones McCoy | Vision | (123)-498-4102 |
| 2 | 2 | Beverly Crusher | Olfactory | (122)-947-2178 |
| 3 | 3 | Ogawa | Research | (102)-738-4957 |
| 4 | 4 | Katherine Pulaski | Research | (102)-999-2716 |
| 5 | 5 | Julian Bashir | Vision | (773)-829-1826 |
| 6 | 6 | Phlox | Cancer | (102)-978-3821 |
| 7 | 7 | Jadzia Dax | Cardiovascular | (100)-283-8477 |
| 8 | 8 | Vic Fontaine | Psychology | (102)-228-3371 |
| 9 | 9 | Kathryn Janeway | Family Psychology | (856)-637-7459 |
| 10 | 10 | Geordi La Forge | Research | (100)-288-4772 |
| 11 | 23 | Dr Strange | Brain Guy | 6618084134 |

Query executed successfully.

After:

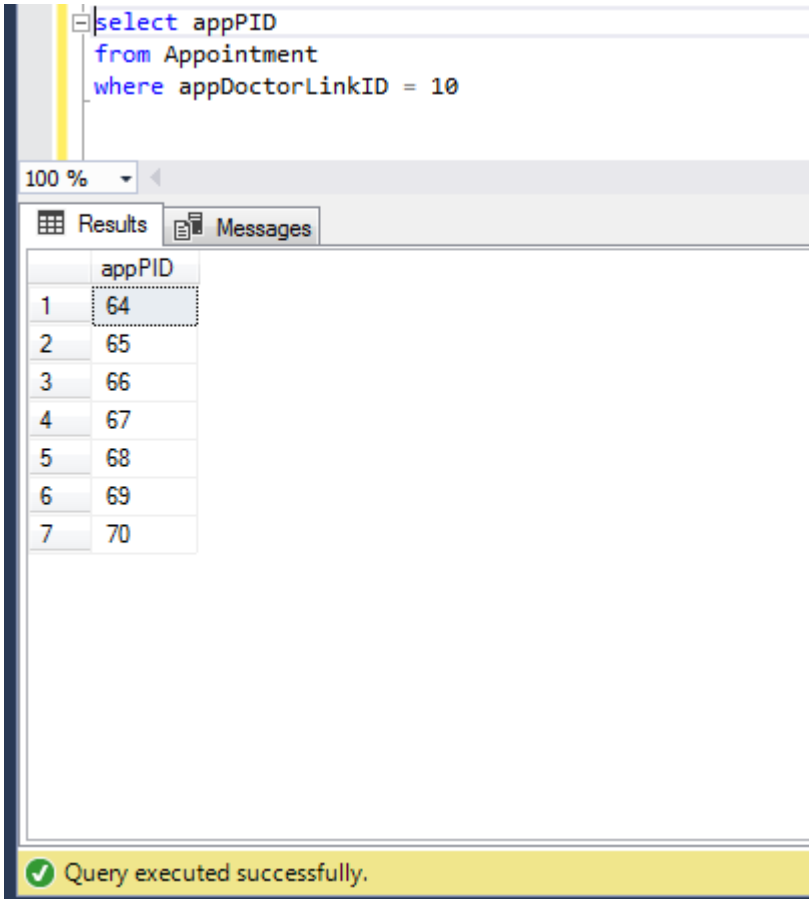



| | docPID | docName | docSpecialization | docPhoneNumber |
|---|---|---|---|---|
| 1 | 1 | Leonard Bones McCoy | Vision | (123)-498-4102 |
| 2 | 2 | Beverly Crusher | Olfactory | (122)-947-2178 |
| 3 | 3 | Ogawa | Research | (102)-738-4957 |
| 4 | 4 | Katherine Pulaski | Research | (102)-999-2716 |
| 5 | 5 | Julian Bashir | Vision | (773)-829-1826 |
| 6 | 6 | Phlox | Cancer | (102)-978-3821 |
| 7 | 7 | Jadzia Dax | Cardiovascular | (100)-283-8477 |
| 8 | 8 | Vic Fontaine | Psychology | (102)-228-3371 |
| 9 | 9 | Kathryn Janeway | Family Psychology | (856)-637-7459 |
| 10 | 10 | Geordi La Forge | Research | (100)-288-4772 |
| 11 | 23 | Hugo Strange | Brain Guy | 6618084134 |

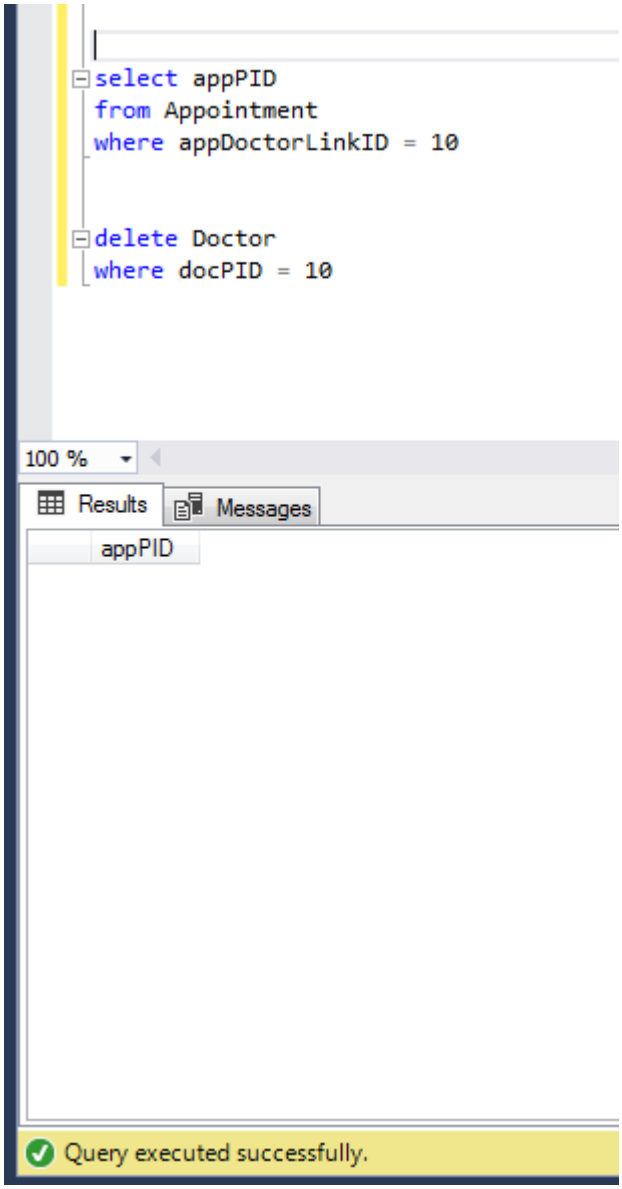
As can be seen, Dr Strange is now Hugo Strange. The docPID is still the same to confirm that it is the same doctor, just with an update name.

**Delete Trigger:** This trigger would delete all appointments related to a doctor that was deleted.

Before


select appPID
from Appointment
where appDoctorLinkID = 10
100 %
Results
Messages
appPID
1 64
2 65
3 66
4 67
5 68
6 69
7 70
Query executed successfully.

After




The trigger was meant to delete all appointments that the deleted doctor was assigned too. So as can be seen above the doctor with PID 11 was assigned to appointments 64 to 70. After the doctor was deleted those appointments were also deleted.

## 4.4 PL/SQL Like Tools (Oracle, Microsoft SQL Server, and MySQL)

This section will cover other types of popular commercial DBMS software. They are all different but at their core they are similar because the goal does not actually change very much. We will compare Oracle PL/SQL, MSS T-SQL, and also MySQL based on syntax and their functionality.

**MySQL**: MySQL is very similar to the other popular DBMS software but it does lack some of the functions that the others do have. For example, MySQL does not support packages. It does not offer packages for namespace like other DBMS software does. It also does not have loops. It does have *while* loops and other

basic loops, but that is it. Another thing to note is that MySQL parameters do work in much the same way as they do in PL/SQL.

Stored procedure:

```
DELIMITER //
CREATE PROCEDURE name of procedure
(IN con CHAR(20))
BEGIN

 SELECT what we want FROM column
 WHERE Continent = con;

END //
DELIMITER ;
```

Stored Function:

```
DELIMITER //
CREATE PROCEDURE name of procedure
(IN con CHAR(20))
RETURN type
BEGIN

 SELECT what we want FROM column
 WHERE Continent = con;

END //
DELIMITER ;
```

While loop:

```
[begin label:] WHILE condition DO
    Statement list
END WHILE [end label]
```

One last thing to note is the use of DELIMITER. This is used to change the traditional end line character of semi-colon(;) to //.

**Microsoft SQL Server: T-SQL :** T-SQL is probably the most unique out of the ones we will be comparing. T-SQL gives the option to encrypt the text of any procedure by simply making use of the with clause. This is useful when trying to restrict access to certain users. T-SQL also allows for the use of multiple *try-catch* blocks in a procedure. This is not possible in PL/SQL and MySQL. T-SQL functions can also return both tables and scalars. This is something that is not possible in MySQL. When it comes to parameters, all passed parameters must be preceded by an '@' character. T-SQL does have its disadvantages. Just like MySQL, T-SQL does not offer the use of *for* loops. Instead only the most basic loops are allowed to be used.

Stored Procedure:

```
CREATE { PROC | PROCEDURE } [schema name.] procedure name [ ; number ]
```

```
        [ { @parameter [ type schema name. ] data type }
                [ VARYING ] [ = default ] [ OUT | OUTPUT | [READONLY]
         ] [ ,...n ]
    [ WITH <procedure option> [ ,...n ] ]
    [ FOR REPLICATION ]
    AS { [ BEGIN ] sql statement [;] [ ...n ] [ END ] }
    [;]
    <procedure option> ::=
        [ ENCRYPTION ]
         [ RECOMPILE ]
         [ EXECUTE AS Clause ]
```

Stored Function:

```
    CREATE FUNCTION [ schema name. ] function name
    ( [ { @parameter name [ AS ][ type schema name. ] parameter data type
        [ = default ] [ READONLY ] }
        [ ,...n ]
      ]
    )
    RETURNS return data type
        [ WITH <function option> [ ,...n ] ]
        [ AS ]
        BEGIN
            Function body
            RETURN scalar expression
        END
    [ ; ]
```

Basic Loop:

```
    WHILE @count < count total
    BEGIN
        {...statements...}
        SET @count = @count + 1
        [;]
     END [;]
```

**Oracle PL/SQL:** This is the DBMS that we mainly focused on in class. It is also the one we used to reference for the creation of this document. This DBMS allows for the use of packages and also for the use of the *for* loop. Both of these two things are not a part of the previously mentioned DBMS software.

Stored Procedure:

```
    CREATE or {REPLACE} PROCEDURE procedure name
    BEGIN
        PL/SQL statements
    END
```

Stored Function:

```
CREATE or {REPLACE} FUNCTION function name
REURN type
BEGIN
        PL/SQL statements
END
```

The loops:

```
WHILE condition
LOOP
        Statements
END LOOP;

FOR counter in range
LOOP
        Statements
END LOOP;
```

# 5. Graphical User Interface Design and Implementation

In this section we will cover what we did for the Graphical User Interface. We will cover how we went about creating the GUI. We will showcase some of the code we used as well as screenshots of the screens the user will encounter and also explanation as to what buttons do what. At the very end of the section we will answer some Survey questions provided by Dr.Wang.

## 5.1 Functionalities and User Group of the GUI Application

This section will cover the basics of the GUI and also showcase some of the code that went into writing this GUI. It will include screen shots and some samples of code that will be given some explanation.

### 5.1.1 Itemized Descriptions of GUI Application

By the time we had to create different User Interfaces for our user groups, we had already begin work together. We did what was instructed and we split the work in terms of the who gets to see what. We had a couple different users that would log in and interact with the database. The level at which they interact with the database varied depending on their access level. The user types are as follows:

**Super User:** The super user has access to everything that can be seen in the GUI. They also have the ability to add and remove users. To also remove their privileges.

**Administrator:** An administrator is assigned to a particular site and is the person in charge or overseer of that particular site. They have the ability to change some aspects of the site.

**Coordinator:** A coordinator is assigned to a particular study within a site by the Administrator of that site. From there they have access to the study but nothing beyond that study.

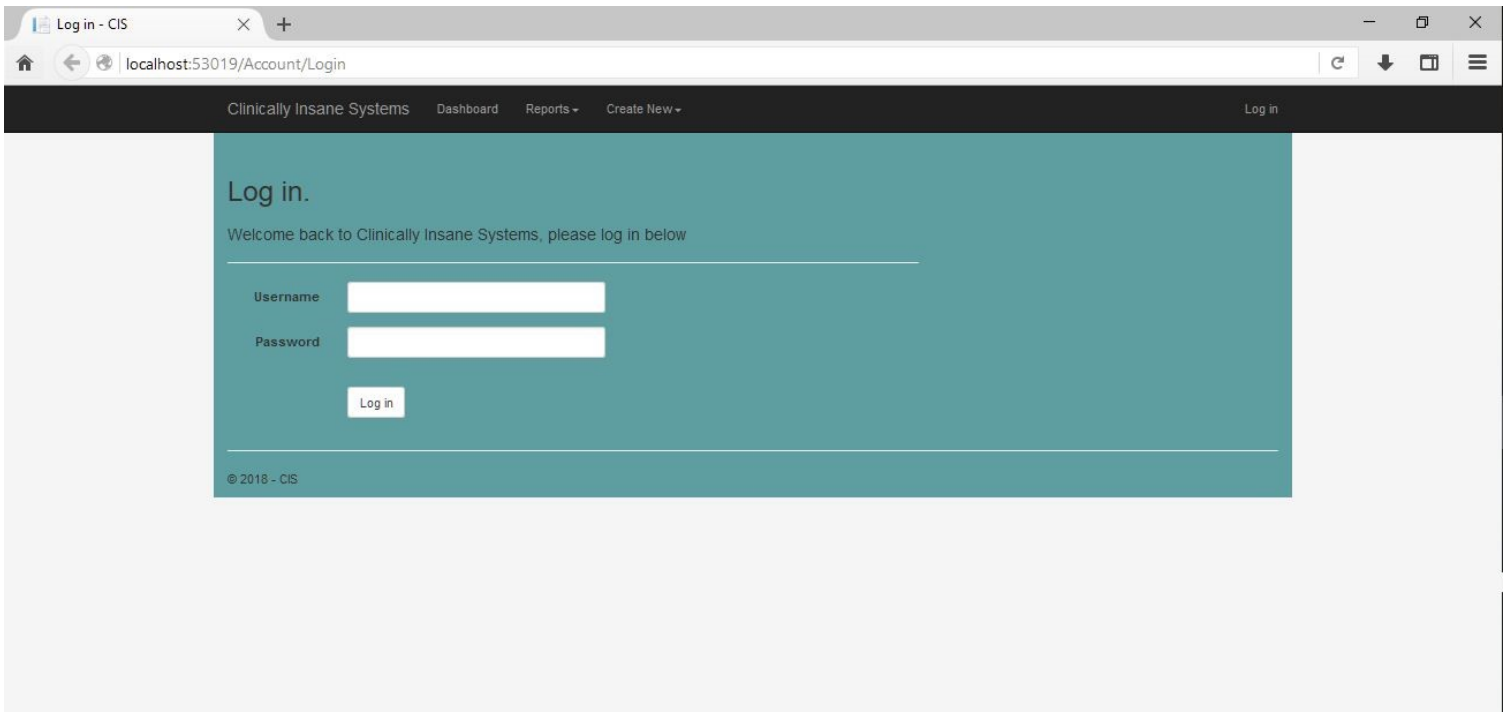
**Monitor:** The monitor is also assigned to a particular study by the Administrator. However, the monitor does not have the ability to make any changes to the study. Their only job is to make sure that those involved are actually doing their jobs.

For this I was put in charge of the Coordinator and the Monitor views. But as can be seem above, they do not have very much functionality. So, while I did work on these two user types, I also worked on other parts of the GUI. Our GUI was very connected that we split the work to make the best possible GUI we could, without one doing all the work.

## 5.1.2 Screen Shots of Application

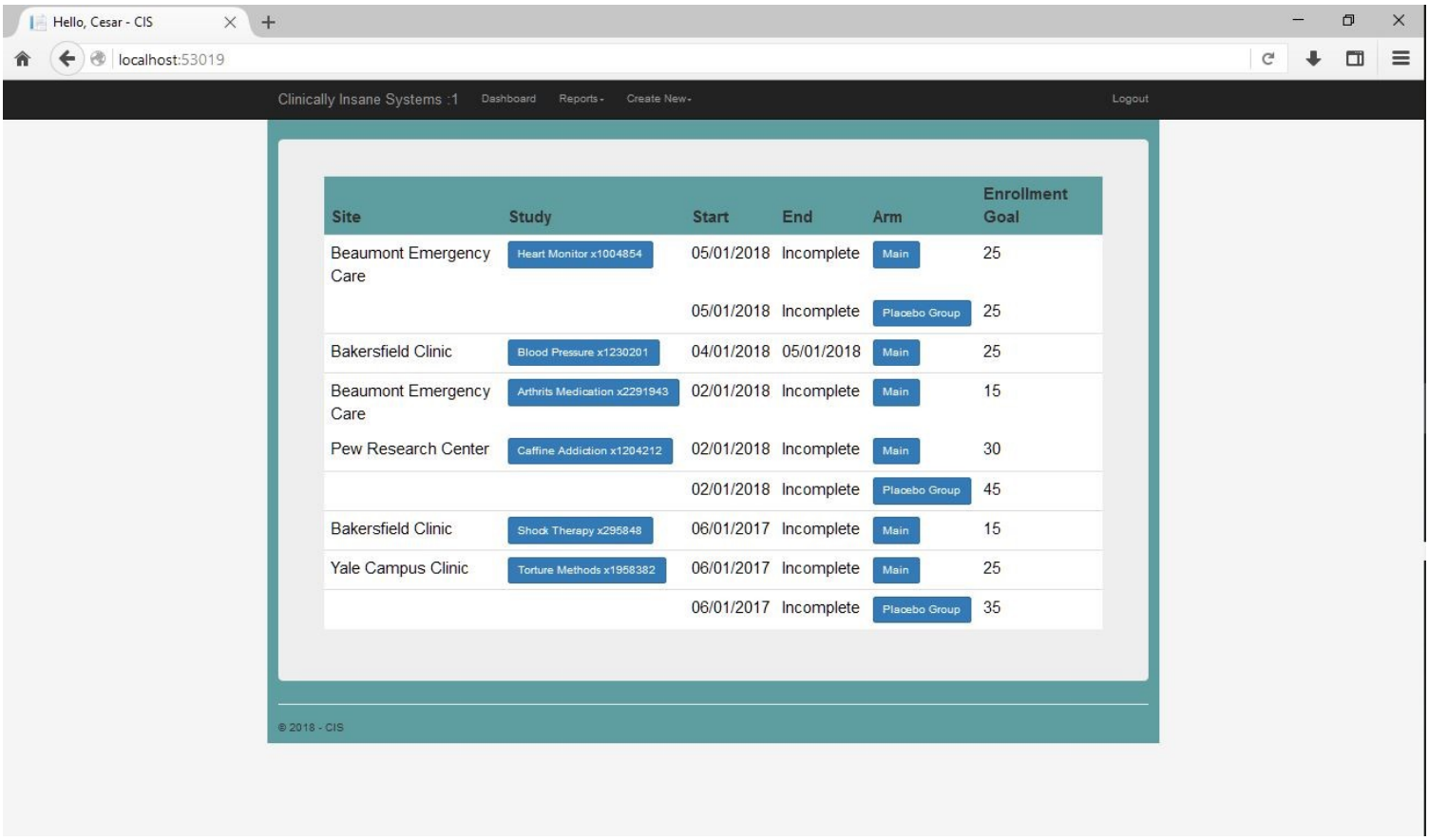
In this section I will show some screenshots of what I worked on during this long process.

**The Login**



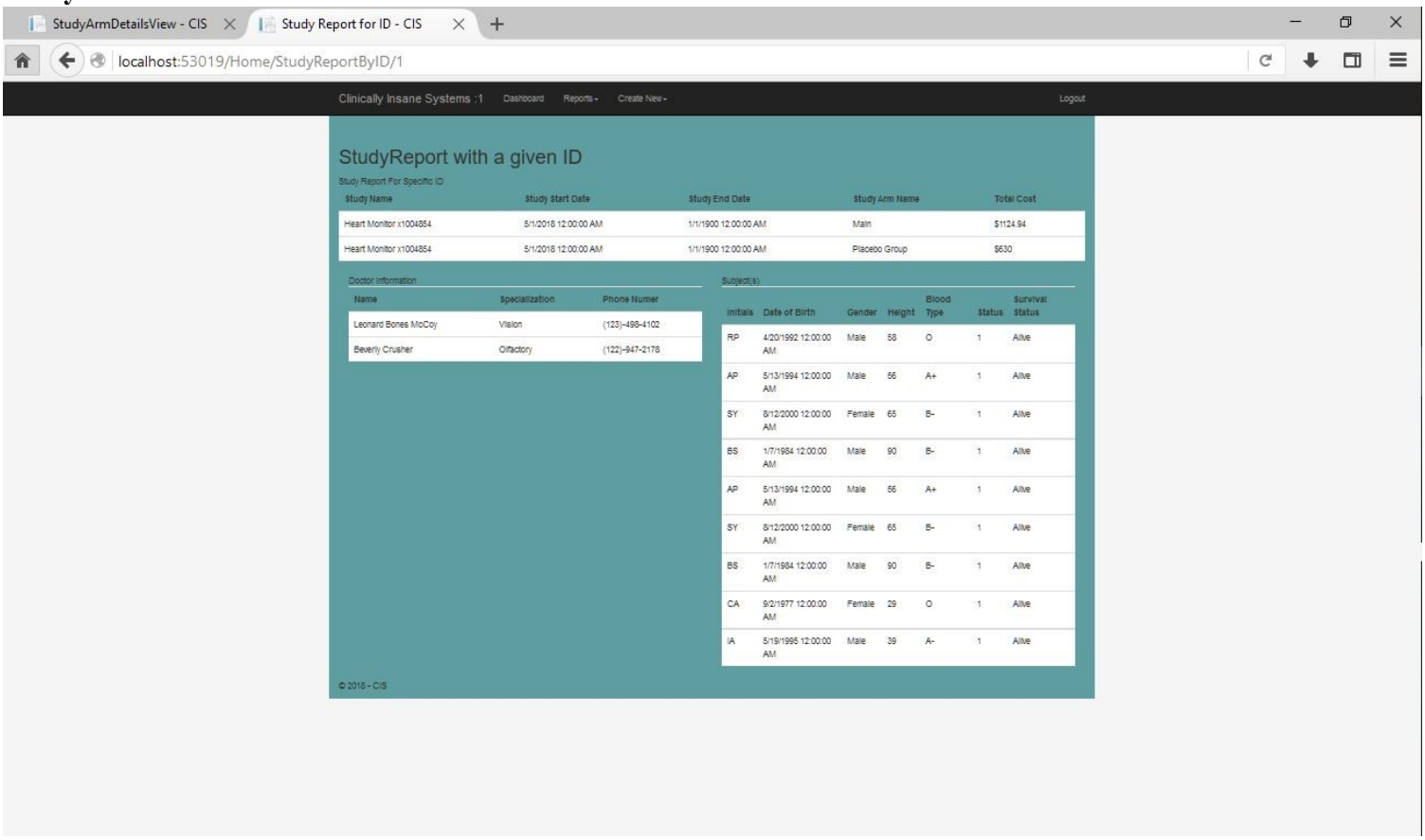
This is what the login page looks like at the time of writing this. This is where the user type is determined. Depending on the user the GUI will change accordingly to show or hide some of the functionality. For the sake of throughout explanation, I will demonstrate what the Super User can see. And along the way, I will specify what the monitor or Coordinator would be able to see and do.

**The Dashboard**



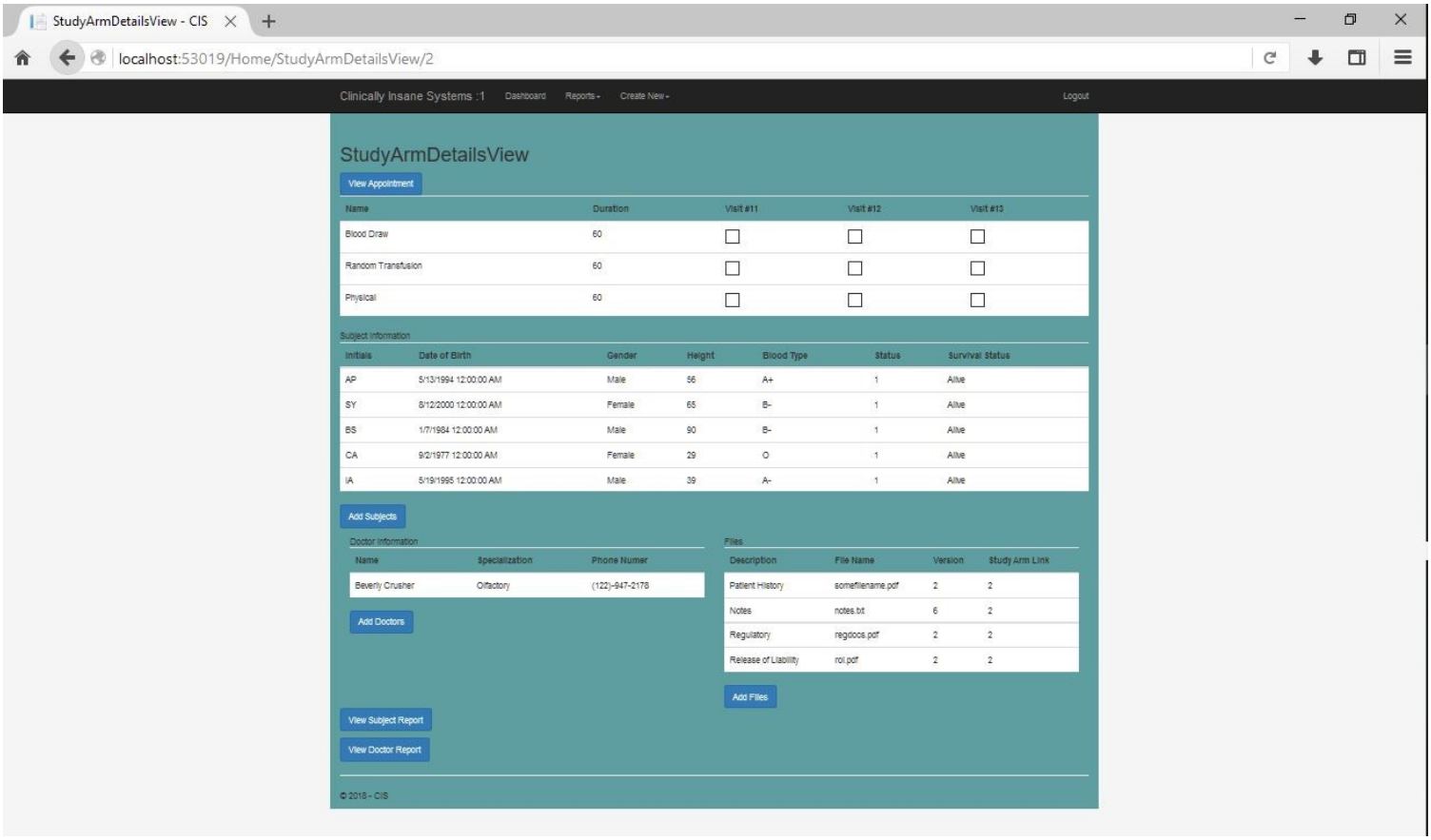

This is the Dashboard that the all users but the monitor see. The Coordinator would also be able to see this page, but it would only display the site that they are involved in. Thus having access to the study details. As the superuser, as in this case, they are able to see all sites and also all studies along with their respective arms.

**Study Details**



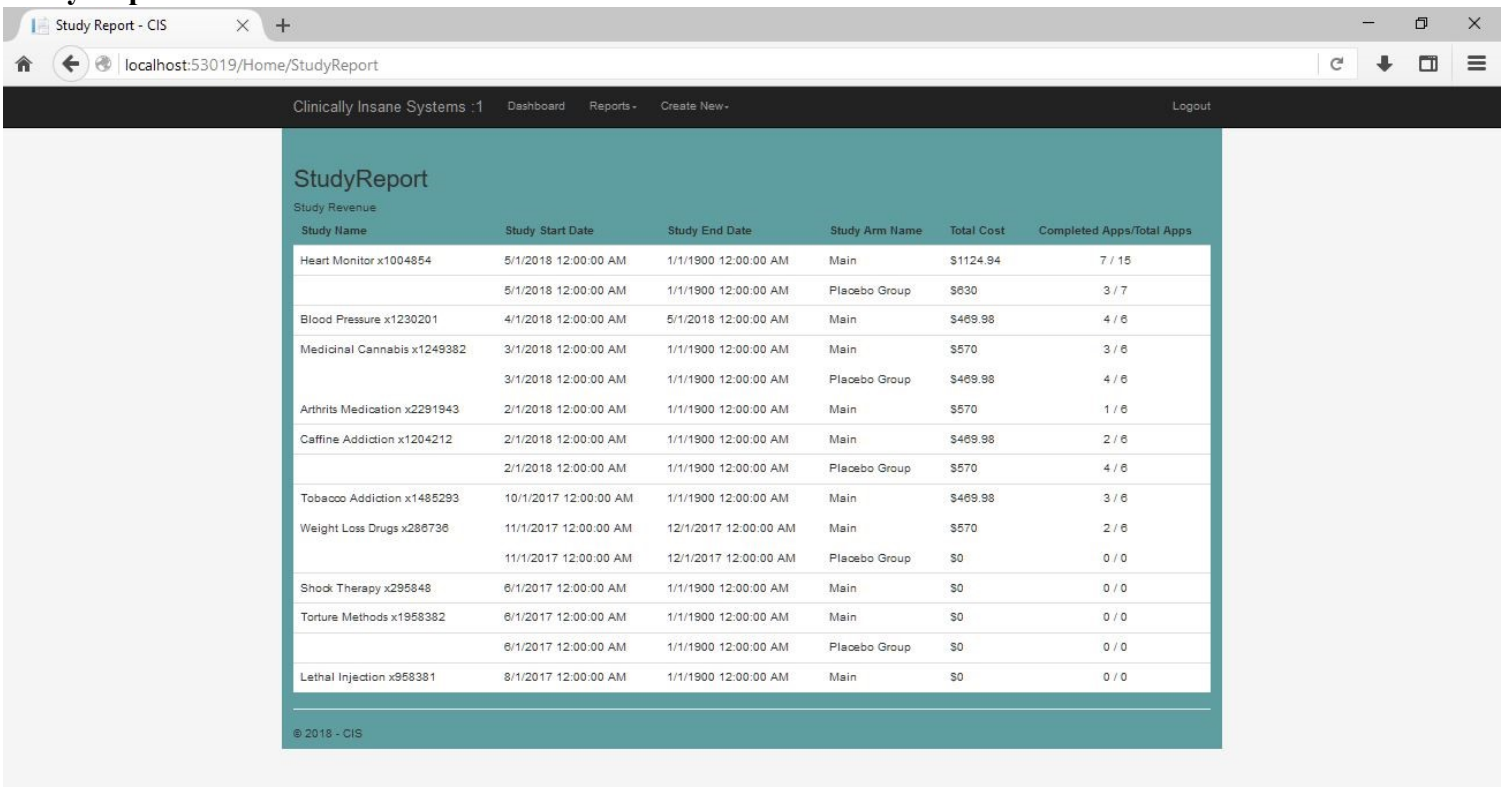

Once the Coordinator has selected their respective study, this is the information that is shown. They are given a status on what is going on within that study. From this page they can see the subjects that are part of the study as well as the doctors. They can also see the study arms that are part of the study. Typically these arm are name “Main” and “Placebo”.

**Study Arm Details**



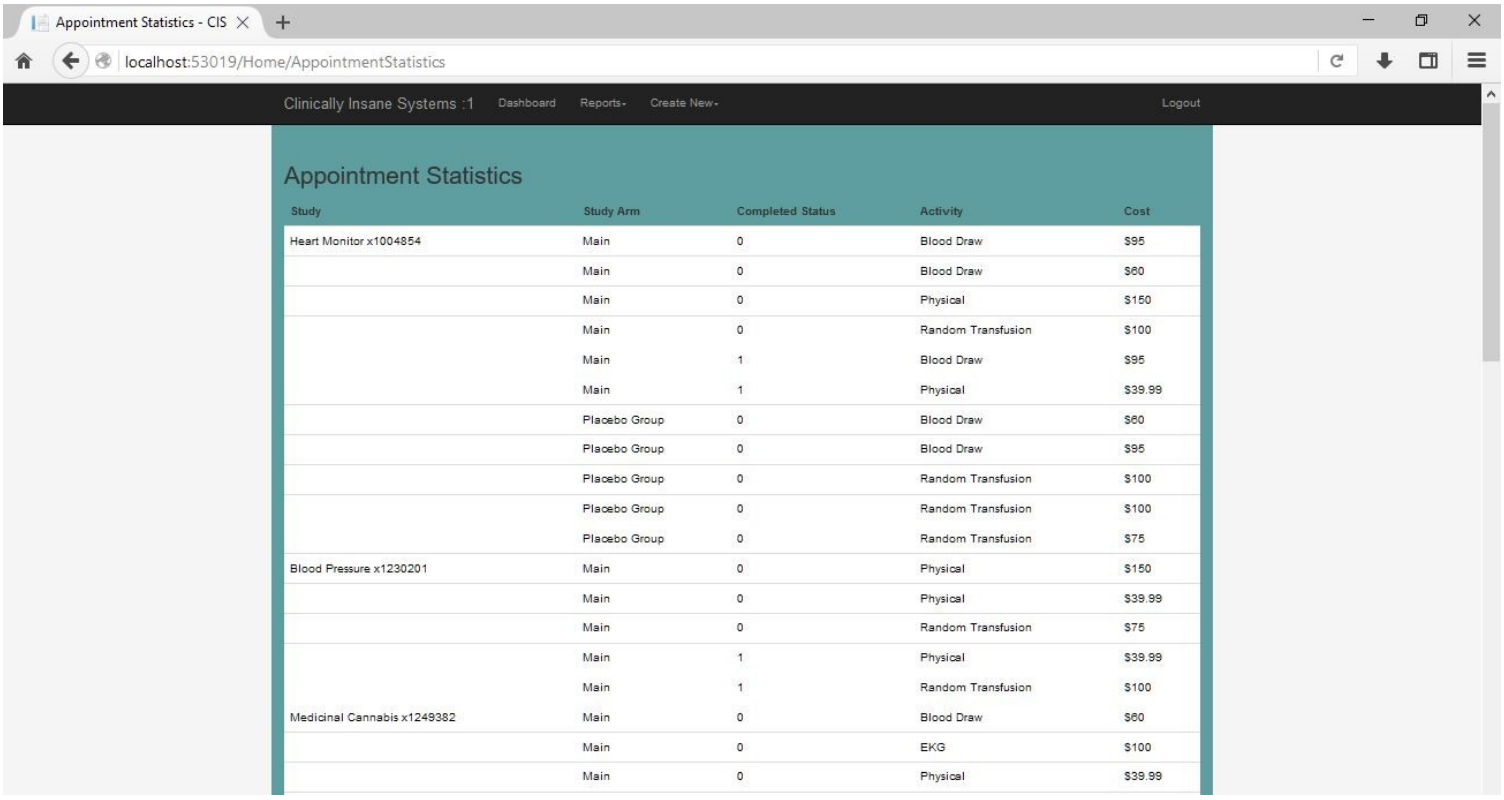

This page can be seen by both the monitor and the coordinator. This page displays more information but specific to the arm. Whether it be the main arm or the placebo arm, this page displays doctors involved, subjects involved, upcoming activities, and also some buttons to show some of the reports for doctor and subject. It also shows some buttons to add doctors and subjects. In the lower right there is a table that shows the documents that are associated with the study arm. It also gives the option to add some documents.

**Study Report**



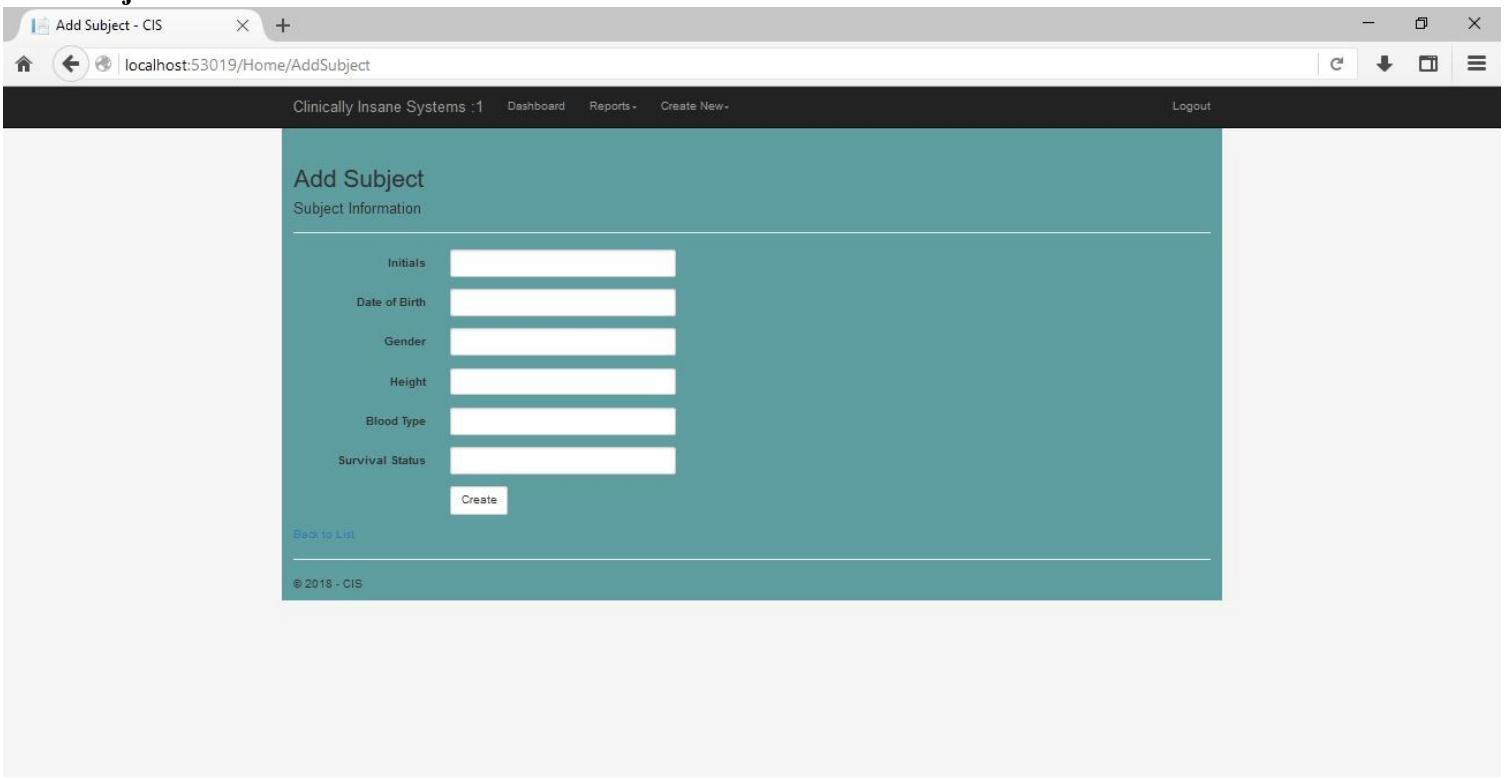

This is a view of a report that shows some information on all studies across all sites. This page would not be visible to the monitor or the coordinator but it is something that I worked on and wanted to showcase. The page shows how much each arm is costing and the amount of appointments each arm has. It also shows the number of appointments completed as compared to those not completed.

**Appointment Statistics Report**



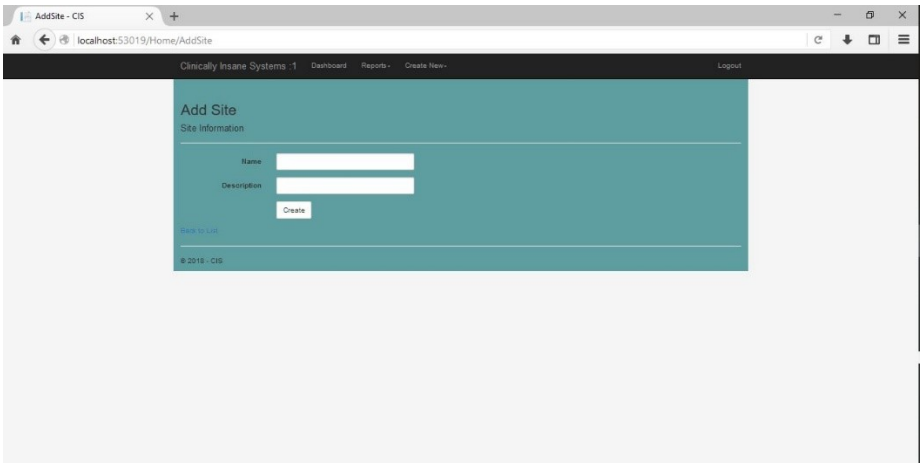

This is another page that I worked on and is not visible to the monitor or the coordinator. This is a statistic page for every appointment that is scheduled for each study and each arm. This report includes those appointments that have been completed and those that have not. It shows the activity associated with the appointment and it also shows the cost of each of those activities.

**Add Subject**




This page is to add a subject to system. As can be seen above, the fields are the basic data that makes up the Subject table. Once valid data is entered and the create button is pressed, the subject is now a part of the system. This is a function that is not available to the monitor but it is available to the coordinator.

**Add Site**




This page is very basic and its only purpose is to add a site to the system. This purpose behind this is for the future creation of new studies. If they require a site that is not in the system then they can be added here. This function is NOT available to the monitor or the coordinator.

## 5.2 Programming Sections

In this section I will cover more of the specific code and provide some explanation for the pages that are found in the previous section. I will select some of the pages and go into details on how they were created. In addition, I will cover how we connected to the database using a connection string and also some more code that I think should be seen. Finally I will quickly cover the client side programming which is essentially the front end and all its components.

### 5.2.1 Server-Side Programming

For this section I will show some code from the project. Including some views and stored procedures. Because of the large amount of views and stored procedures, I will only show three of the ones that took the most thought. Since I see that this section is similar to 5.2.1 I will demonstrate these shots of code in that section. Here I will show some of the tables that we get in our GUI along with the stored procedure and view that makes it up.

This following section of code will the for the Study Report that was shown in section 5.1.2:

**View:**

```
CREATE VIEW [dbo].[v_StudyReport]
AS SELECT stuPID, sarPID, stuName, stuStartDate, stuEndDate, sarName, ISNULL(sum(appCompletedStatus), 0) AS
NumberCompleted, ISNULL(SUM(actCost), 0.0) AS TotalCost, count(appPID) as TotalApp
FROM Appointment
       right outer join Activity on actPID = appActivityLinkID
       right outer join StudyArm on sarPID = actStudyArmLinkID
       right outer join Study on stuPID = sarStudyLinkID
GROUP BY stuPID, sarPID, stuName, sarName, stuStartDate, stuEndDate
GO
```

**Stored Procedure:**

```
CREATE PROC [dbo].[sp_DoctorReport](@docPID int) AS
Select *
FROM v_DoctorReport
WHERE docPID = @docPID
```

**Code in Visual Studio**

```
public ActionResult StudyReport(int? id)
{
    var sqlStuff = new SqlStuff();
    var data = sqlStuff.StudyReport();

    var model = new List<StudyReportViewModel>();
    model = ConvertDataTable<StudyReportViewModel>(data);

    return View(model);
}
```

```
static string GetAppointmentStatistics = "sp_AppointmentStatistics";
static string GetDoctorReport = "sp_DoctorReport";
static string GetSubjectReport = "sp_SubjectReport";
static string GetStudyReportByID = "sp_StudyReportByID";
static string GetStudyReport = "sp_StudyReport";
```

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Web;

namespace Bryan_GUI.Models
{
    public class DoctorReportViewModel
    {
        public DoctorReportViewModel()
        {

            appPID = 0;
            docPID = 0;
            docName = "";
            stuName = "";
            sarName = "";
            appCompletedStatus = 0;
        }
        public int appPID { get; set; }
        public int docPID { get; set; }
        public string docName { get; set; }
        public string stuName { get; set; }
        public string sarName { get; set; }
        public int appCompletedStatus { get; set; }
    }
}
```

These pieces of code will combine together to give the view that can be seen in section 5.2.1. The first piece is the view which takes appointment and joins the section from Activity, StudyArm, and Study. After that we go to the stored procedure that just selects all from the view. From there we jump into Visual studio into what is know as the home controller which creates the action for the view. Then we go into another file in our visual project which links the stored procedure to Visual Studio. The "GetDoctorReport" has the name of the stored procedure that was created in SSMS.

The follow section of code will be about the page Appointment Statistics that can be seen in section 5.2.1.

**View:**

```
ALTER VIEW [dbo].[v_AppointmentStatistics] AS
SELECT appCompletedStatus, stuName, sarName, appPID, stuPID, sarPID, actName, actCost
FROM Appointment
	inner join StudyArm on appStudyArmLinkID = sarPID
	inner join Study on sarStudyLinkID = stuPID
	inner join Activity on appActivityLinkID = actPID
```

**Stored Procedure:**

```
ALTER PROC [dbo].[sp_AppointmentStatistics]
AS
```

```
SELECT        stuName, sarName, appCompletedStatus, actName, actCost
FROM          v_AppointmentStatistics
order         by stuPID, sarPID, appCompletedStatus, actName
```

**Code from Visual Studio:**

```
public DataTable AppointmentStatistics()
{
    var returnValue = new DataTable();
    using (var sqlConnection = GetControlConnection())
    {
        using (var sqlCommand = new SqlCommand(GetAppointmentStatistics, sqlConnection))
        {
            sqlCommand.CommandType = CommandType.StoredProcedure;
            //sqlCommand.CommandTimeout = 60; // one minute timeout
            sqlConnection.Open();

            using (var sqlDataAdapter = new SqlDataAdapter(sqlCommand))
            {
                sqlDataAdapter.Fill(returnValue);
            }
        }
    }
    return returnValue;
}
```

```
static string GetAppointmentStatistics = "sp_AppointmentStatistics";
static string GetDoctorReport = "sp_DoctorReport";
static string GetSubjectReport = "sp_SubjectReport";
static string GetStudyReportByID = "sp_StudyReportByID";
static string GetStudyReport = "sp_StudyReport";
```

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Web;

namespace Bryan_GUI.Models
{
    public class AppointmentStatisticsViewModel
    {
        public AppointmentStatisticsViewModel()
        {
            stuName = "";
            sarName = "";
            appCompletedStatus = 0;
            actName = "";
            actCost = 0.0;
        }

        public string stuName { get; set; }
        public string sarName { get; set; }
        public int appCompletedStatus { get; set; }
        public string actName { get; set; }
        public double actCost { get; set; }
    }
}
```

The code above shows how I went about creating the Appointment Statistics Report. First I created the view which was very simple and the next step was also simple, just a select all from the previously created view. After that I jump into Visual Studio to

create a view model that will receive the data from the data base and give them variables name that match those that they have. Next, like previously, I created the link to the database stored procedure than created an action link to it.

The last section I will demonstrate is another page that can be seen above the section 5.2.1.

**View:**

```
ALTER VIEW [dbo].[v_AppointmentStatistics] AS
SELECT appCompletedStatus, stuName, sarName, appPID, stuPID, sarPID, actName, actCost
FROM Appointment
       inner join StudyArm on appStudyArmLinkID = sarPID
       inner join Study on sarStudyLinkID = stuPID
       inner join Activity on appActivityLinkID = actPID
```

**Stored Procedure:**

```
ALTER proc [dbo].[sp_StudyReportByID](@stuPID int) as
select *
from v_StudyReport
where stuPID = @stuPID
```

**Code from Visual Studio:**

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Web;

namespace Bryan_GUI.Models
{
    public class StudyReportBIGModel
    {
        public List<StudyDetailViewModel> studyDetails { get; set; }
        public List<Doctor> doctors { get; set; }
        public List<Subject> subjects { get; set; }

    }
}
```

```
public DataTable StudyReportByID(int stuPID)
{
    var returnValue = new DataTable();
    using (var sqlConnection = GetControlConnection())
    {
        using (var sqlCommand = new SqlCommand(GetStudyReportByID, sqlConnection))
        {
            sqlCommand.CommandType = CommandType.StoredProcedure;
            sqlCommand.Parameters.Add(new SqlParameter("stuPID", stuPID));
            sqlConnection.Open();

            using (var sqlDataAdapter = new SqlDataAdapter(sqlCommand))
            {
                sqlDataAdapter.Fill(returnValue);
            }
        }
    }
    return returnValue;
}
```

```
static string GetAppointmentStatistics = "sp_AppointmentStatistics";
static string GetDoctorReport = "sp_DoctorReport";
static string GetSubjectReport = "sp_SubjectReport";
static string GetStudyReportByID = "sp_StudyReportByID";
static string GetStudyReport = "sp_StudyReport";
```

```
30
31          static string GetDoctorsByStudyArm = "sp_DoctorsByStudyArm";
32          static string GetSubjectsByStudyArm = "sp_SubjectsByStudyArm";
33          static string GetDocumentsByStudyArm = "sp_DocumentsByStudyArm";
34          static string GetVisitsByStudyArm = "sp_VisitsByStudyArm";
35          static string GetActivitiesByStudyArm = "sp_ActivitiesByStudyArm";
36          static string GetAppointmentsByStudyArm = "sp_AppointmentsByStudyArm";
37
```

Here is the code for the Study Report page that includes the information of the study. This includes the arms, basic doctor information, and basic subject information. First to do this I had to create big model that would enclose study details, doctors, and subjects. The reason behind this is because this was the only way I could find to show multiple models in one page. Once the big model was created the rest was simple. I made the link to the database with the “Get” strings in the file. Then after that I made the action link, then the cshtml page to actually show the information in the page.

## 5.2.2 Middle-Tire Programming

This section is to show how we connected to the database. We did this with a connection string, which can be seen below:

```
11  <connectionStrings>
12    <add name="DefaultConnection" connectionString="Data Source=(LocalDb)\MSSQLLocalDB;AttachDbFilename=|DataDirectory|\aspnet-Bryan_GUI-20180405013351.mdf;Initial Catalog=aspnet-Bryan_GUI-20180405013351;Integrated Security=True" providerNa
13    <add name="SiteContext" connectionString="metadata=res://*/Models.Bryan_GUI_DataModel.csdl|res://*/Models.Bryan_GUI_DataModel.ssdl|res://*/Models.Bryan_GUI_DataModel.msl;provider=System.Data.SqlClient;provider connection string=&quot;da
14  </connectionStrings>
```

The connection string is far too long to show but here is the fist third of the string. The string makes and establishes the connection to the database. The string is given to us by the host of the database, in our case Winnhost. The string is the reason we can connect stored procedures to a variable in out files.

One more thing I would like to highlight is a section of CSHTML code that creates a grid on checkboxes.

```
<h2>StudyArmDetailsView</h2>

<div>
    <table class="table">
        <tr>
            @Html.ActionLink("View Appointment", "Appointments", new { studyArmPID = 2 }, new { @class = "btn btn-primary" })
            <th>Name</th>
            <th>Duration</th>
            @foreach (var vis in Model.visits)
            {
                <th>Visit #@vis.visPID</th>
            }
        </tr>
        <tbody>
            @foreach (var item in Model.activities)
            {
                <tr>
                    <td>@item.actName</td>
                    <td>@item.actDuration</td>
                    @foreach (var vis in Model.visits)
                    {
                        <td><input class="form-check-input position-static" type="checkbox" id="blankCheckbox" value="option1" aria-label="..."></td>

                    }
                </tr>
            }
    </table>
</div>
```

| Name | Duration | Visit #1 | Visit #2 | Visit #3 | Visit #4 | Visit #5 | Visit #6 | Visit #7 | Visit #8 | Visit #9 | Visit #10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Blood Draw | 60 | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Random Transfusion | 60 | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Physical | 60 | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| EKG | 60 | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Checkup | 60 | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Subject Information

This section of code took me a good amount of time to create. Its purpose is to make it easier for the user to create appointments by just checking the boxes. At this moment we are still unsure if we should use it. But regardless I think it should be seem if it does not make it to the final product.

## 5.2.3 Client-Side Programming

There are several executions that are being executed from the client side. Some examples can be seen in the add screens and other sections of the programs. The way it worked was that we sent a request to the back-end and received a response. Whether it worked the response we wanted, is a different story. That depends on how well we coded it.

## 5.3 Survey Questions

| Outcome | Cesar Aleman | Bryan Sander |
|---|---|---|
| An ability to analyze a problem, identify, and define the computing requirements and specifications appropriate to its solution. | 8 | 9 |
| An ability to design, implement and evaluate a computer-based system, process, component, or program to meet desired needs. An ability to understand the analysis, design, and implementation of a computerized solution to a real-life problem. | 8 | 10 |
| An ability to communicate effectively with a range of audiences. An ability to write a technical document such as a software specification white paper or a user manual. | 9 | 8 |
| An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices. | 8 | 8 |