UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Database Management Systems, A.Y. 2017/2018
Master Degree in Computer Engineering
Master Degree in Telecommunication Engineering

Homework 3 – Logical Design

Deadline: May 4, 2018

LeoForFriendsDB	TreatIT	
Da Lio	Edoardo	1174591
Giovannini	Stefano	1178044
Kalakonda	Srikanth Reddy	1178232
Rossi	Gianmaria	1178526
Zhang	Guangzheng	1178043

Variations to the Conceptual Design

Here follows the list of the transformations with respect to the Conceptual Design.

Transformation of the Entity-Relationship Schema

The original ER schema is reported in Figure 1 at the next page, while its modified version is reported in Figure 2, which can be found at the subsequent one.

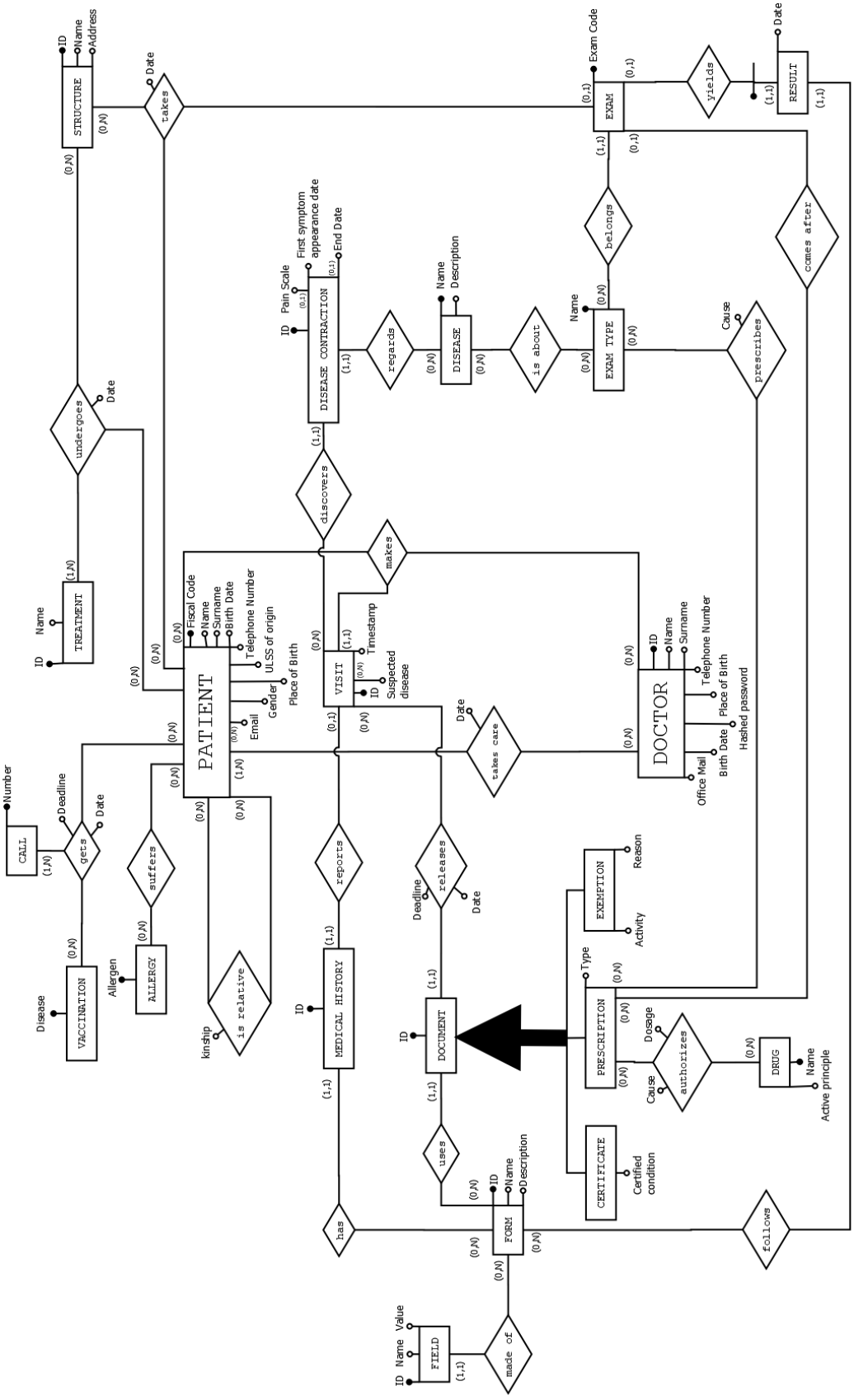


Figure 1: The original ER schema

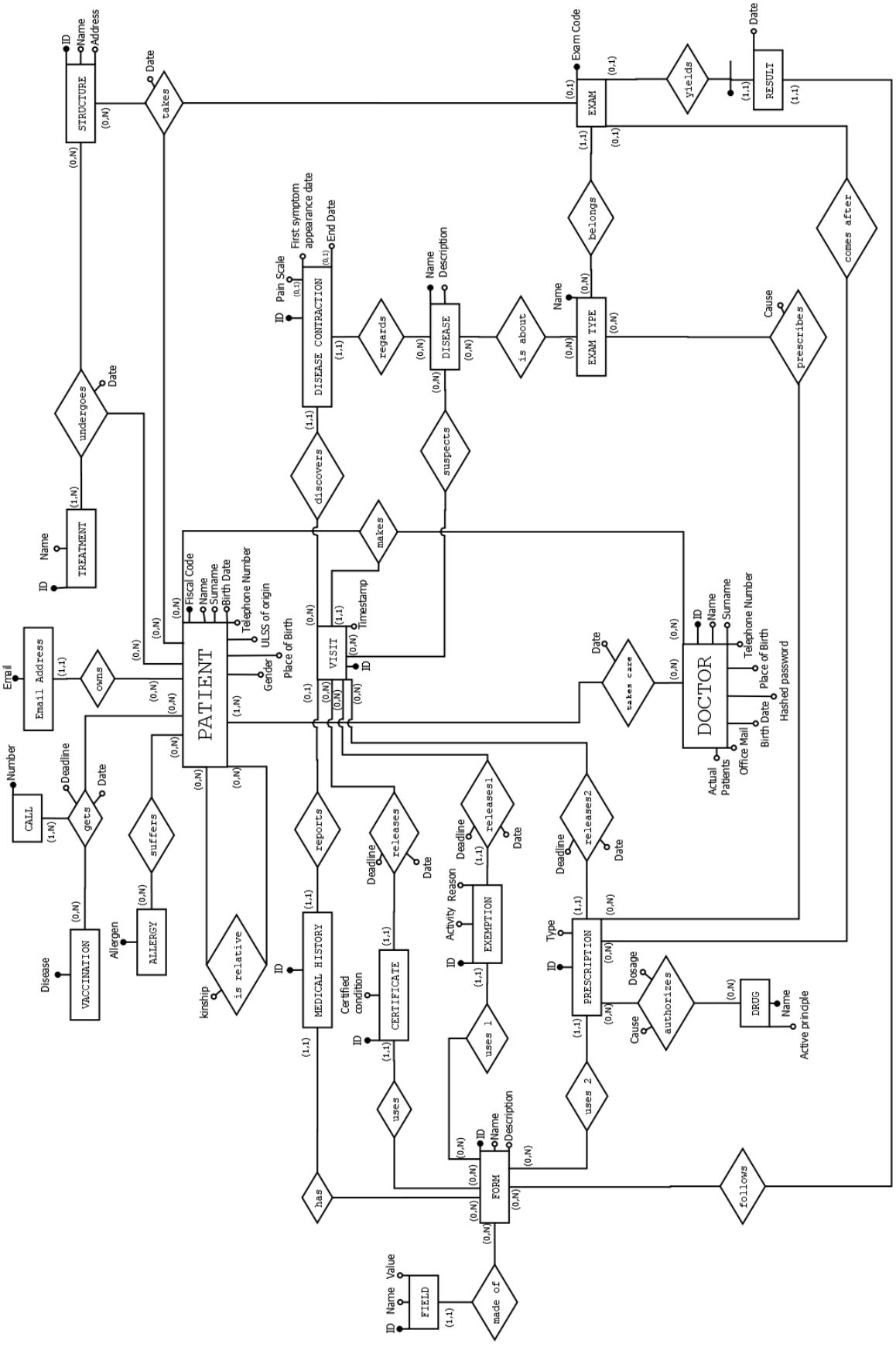


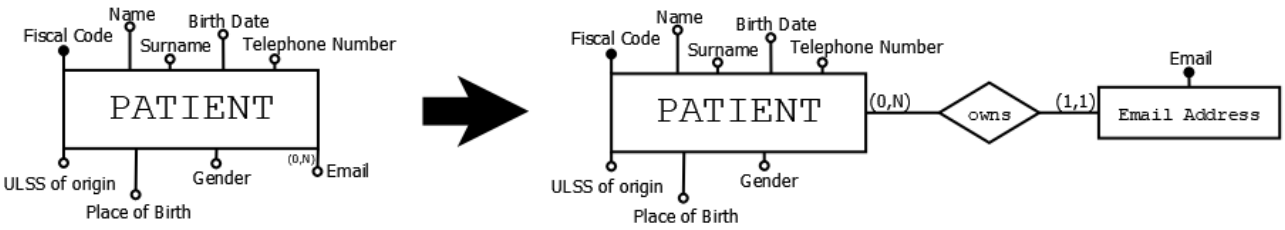
Figure 2: The transformed ER schema

1. Redundancy Analysis

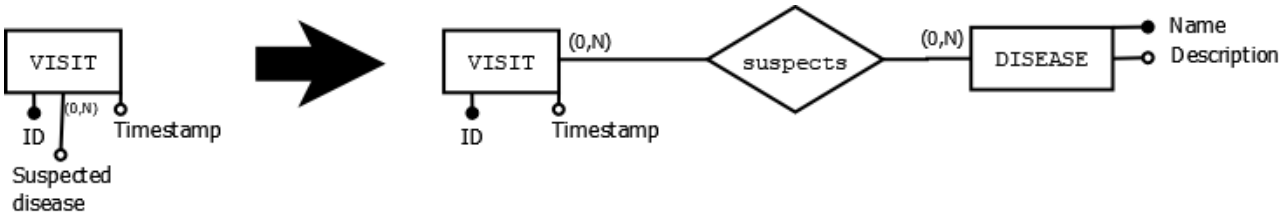
Intensional redundancy: no intensional redundancy is present in the schema
Extensional redundancy: the schema does not include any cycle of entities.
No redundant entity nor redundant attributes were found.
Anyway, in the Load Analysis section we considered the addition of a redundant "Actual Patients" attribute on the Doctor entity in order to keep track of the amount of people a doctor takes care of.
As explained in the aforementioned section, the addition proves to be worthy.

2. Removal of Multi-Valued Attributes

Two Multi-Valued attributes are present in the ER schema: "Email" on Patient and "Suspected Disease" on Visit. In the case of Email, since it has cardinality (0,N), it is replaced by an additional Entity with the same name linked to Patient via a "Owns" relationship. The cardinalities are (1,1) on the side of Email and (0,N) on the side of Patient. The modification is illustrated by the below figure.



The case of "Suspected Disease" is treated differently: being a Disease entity already existent, the attribute is replaced by an additional relationship "suspects" linking Visit to Disease. Cardinalities on both sides are (0,N), as can be seen in the following figure.

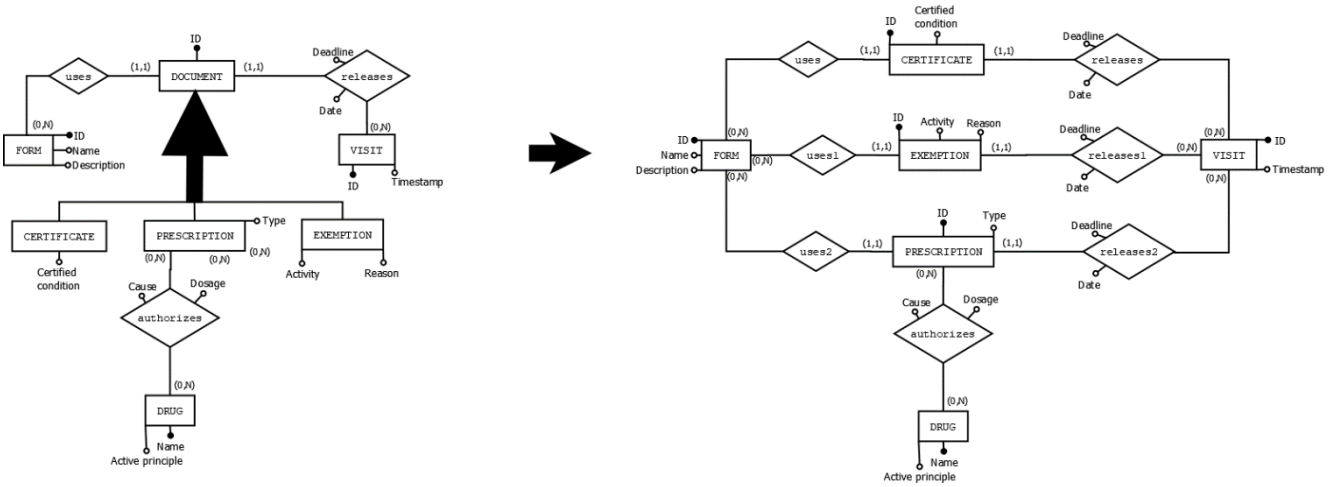


3. Removal of Composite Attributes

No composite attributes are present in the ER schema.

4. Removal of IS-A Relations and Generalizations

No IS-A Relations are present in the original ER schema.
A single Generalization is present and involves Certificate, Prescription and Exemption Entities generalized into the Document one. This Generalization is removed and replaced with three distinct subclass entities and relationships by merging the superclass into all the subclasses (Option 3).
The only attribute of the superclass is added to each subclass.
This choice is performed because the generalization is complete and disjoint and because each operation always involves attributes by the superclass and subclass together, but never the superclass' ones alone.
The already described process is shown in the following Figure.



5. Choice of Principal Identifiers

The schema does not contain external identification cycles.

6. Specification of Additional External Constraints

No need for additional external constraints is found.

7. Variations to the Data Dictionary

The following section lists the variation to the entities and relationships tables of the data dictionary.

Entities Table

Only the Document Entity is removed from the original ER schema.
The following entities are added or modified in the transformed version:

Entity	Description	Attributes	Identifier
Doctor	Someone providing medical care	• ID, unique identifier for the doctor made by 4 numbers, text; • Hashed password, doctor personal password saved in hashed form for security, text; • Name, the name of the doctor, text; • Surname, the surname of the doctor, text; • Birth Date, date of birth of the doctor, date; • Place of Birth, place where the doctor is born, text; • Telephone Number, telephone number of the doctor, text; • Office Mail, the professional email address of the doctor, text.	ID

		• Actual Patients, the number of patients a doctor is taking care of, integer.	
Patient	Someone under medical care	• Fiscal Code, unique alphanumeric string provided by the country administration, text; • Name, the name of the patient, text; • Surname, the surname of the patient, text; • Gender, gender of the patient, text; • Birth Date, date of birth of the patient, date; • Place of Birth, place where the patient is born, text; • Telephone Number, telephone number of the patient, text; • ULSS of origin, ULSS from where the patient belongs to, text.	Fiscal Code
Email Address	The email address of a patient	• Email, the email address of a patient, text.	Email
Visit	The meeting of Doctor and Patient aimed to check Patient's health conditions	• ID, an increasing number, (long) integer; • Timestamp, a timestamp including time and date of the visit, timestamp.	ID
Certificate	Document written by the doctor to provide a promissory note regarding health conditions of the patient	• ID, unique identifier for the certificate, derived from the visit one, text; • Certified Condition, the condition for which the certificate is released, text.	ID
Exemption	Document attesting someone's authorization not to pay taxes for a certain medical performance	• ID, unique identifier for the certificate, derived from the visit one, text; • Reason, the motivation for which the exemption is given, text; • Activity, the activity targeted by the exemption, text.	ID
Prescription	Medication suggested by the doctor	• ID, unique identifier for the certificate, derived from the visit one, text; • Type, the type of the medical prescription, text.	ID

Relationships Table

Only the “releases” Relationship is removed from the original ER schema.
The following entities are added in the transformed version:

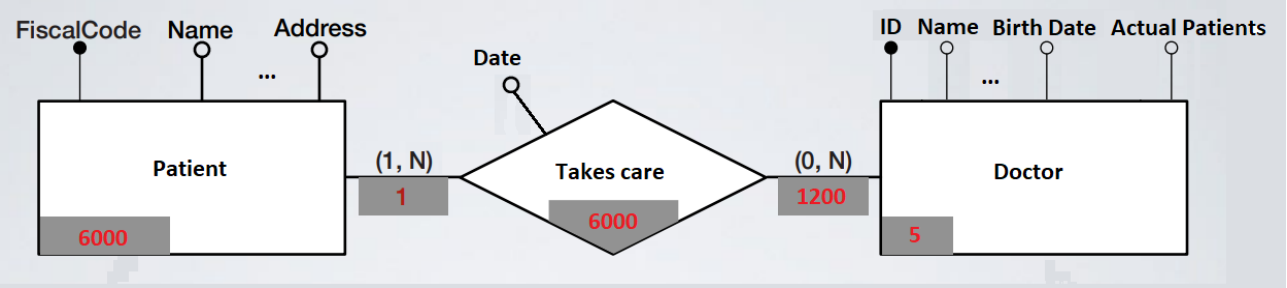
Relationship	Description	Component Entities	Attributes
Owns	A Patients owns one or more Email Addresses	• Patient, (0,N); • Email Address, (1,1).	-
Suspects	One or more Diseases can be suspected during a Visit	• Visit (0,N); • Disease, (0,N);	-
Releases	A Certificate is released during a Visit	• Certificate, (1,1); • Visit, (0,N).	• Date, the date on which the Certificate is released, date; • Deadline, the date up to which the Certificate is valid, date.
Releases1	An Exemption is released during a Visit	• Exemption, (1,1); • Visit, (0,N).	• Date, the date on which the Exemption is released, date; • Deadline, the date up to which the Exemption is valid, date.
Releases1	A Prescription is released during a Visit	• Prescription, (1,1); • Visit, (0,N).	• Date, the date on which the Prescription is released, date; • Deadline, the date up to which the Prescription is valid, date.

Analysis of Database Load

A doctor is interested in knowing how many patients he currently has under his care. Therefore, it is necessary to consider if a derived attribute that counts the number of the current patients of a doctor (Actual Patients) is worthy to be added to the Doctor entity.
Since the additional attribute Actual Patients may slow down the operation that allows the insertion of a new patient in the system, also this operation will be considered in this analysis.

OPERATION	DESCRIPTION	FREQUENCY	TYPE
O1 Insert a new patient	Insertion of a new patient in the database	20/day	Online
O2 Check the number of patients of a single doctor	Retrieve the number of patients that are currently under care of a doctor already registered in the system	5/day	Online

The estimated data volume of the interested part of the schema is the following:

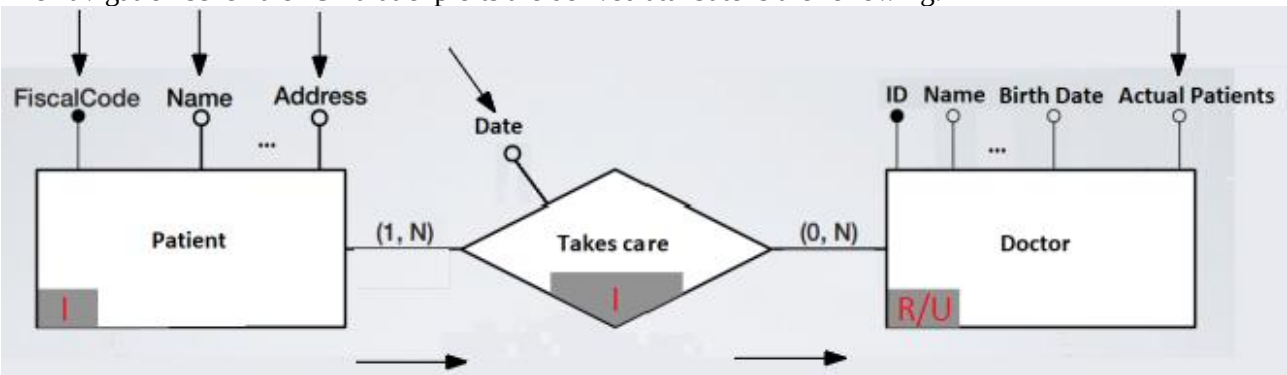


The previous schema can be summarized in the following table:

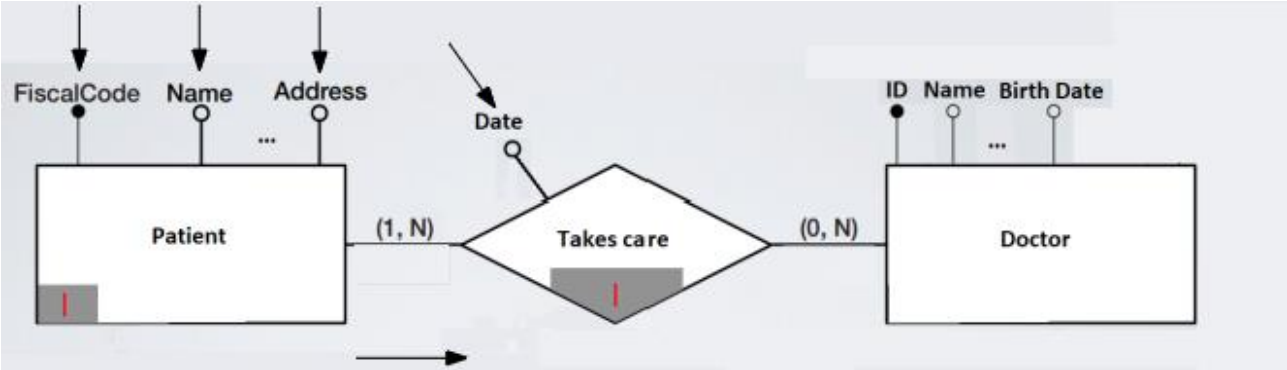
CONCEPT	CONSTRUCT	VOLUME
Patient	Entity	6000
Doctor	Entity	5
Takes Care	Relationship	6000

O1 NAVIGATION SCHEMAS

The navigation schema of O1 that exploits the derived attribute is the following:

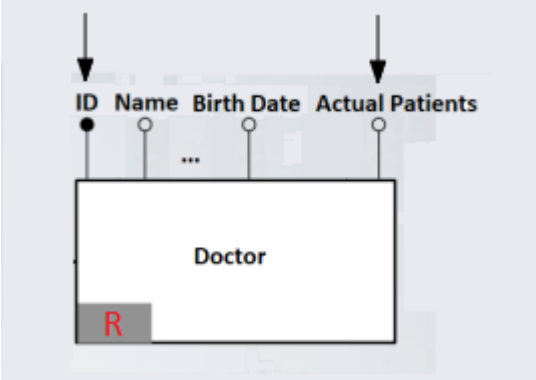


The navigation schema of O1 that doesn't use the derived attribute is:

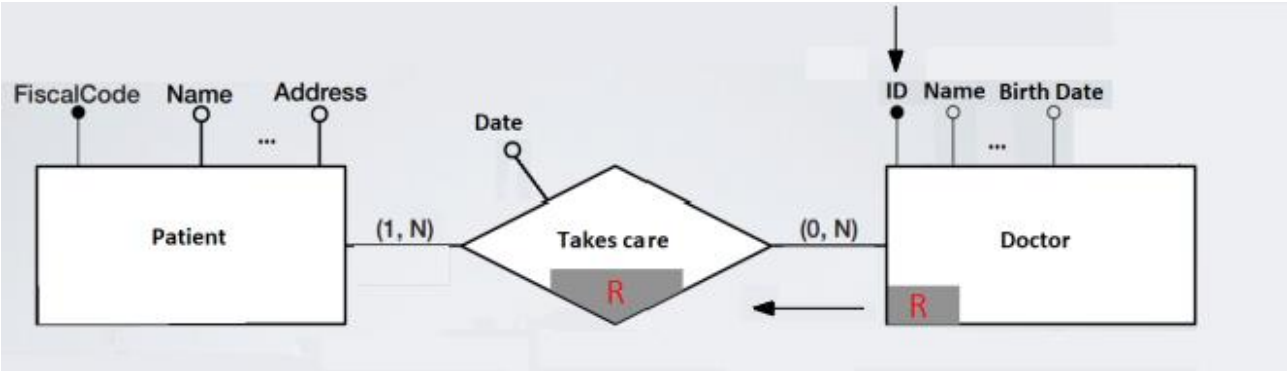


O2 NAVIGATIONS SCHEMAS:

The navigation schema of O2 that exploits the redundant attribute is:



While the navigation schema that doesn't use the redundant attribute is:



ACCESS/VOLUME TABLES FOR O1:
With redundancy:

CONCEPT	CONSTRUCT	ACCESS	TYPE	AVERAGE ACCESS
Patient	Entity	1	W	1x20x2=40
Doctor	Entity	1	R	1x20x1=20
Doctor	Entity	1	W	1x20x2=40
Takes Care	Relationship	1	W	1x20x2=40
TOTAL= 40 ACCESSES				

Without redundancy:

CONCEPT	CONSTRUCT	ACCESS	TYPE	AVERAGE ACCESS
Patient	Entity	1	W	1x20x2=40
Takes Care	Relationship	1	W	1x20x2=40
TOTAL = 80 ACCESSES				

ACCESS/VOLUME TABLE FOR O2:
With redundancy:

CONCEPT	CONSTRUCT	ACCESS	TYPE	AVERAGE ACCESS
Doctor	Entity	1	R	1x5x1=5
TOTALE= 5 ACCESSES				

Without redundancy:

CONCEPT	CONSTRUCT	ACCESS	TYPE	AVERAGE ACCESS
Doctor	Entity	1	R	1x5x1=5

Takes Care	Relationship	1200	R	1200x5x1=6000
TOTALE= 6005 ACCESSI				

CONCLUSIONS OF THE LOAD ANALYSIS:

	WITH REDUNDANCY	**WITHOUT REDUNDANCY**
O1	140	80
O2	5	6005
TOTAL	145	6085

As the previous table highlights, the derived attribute Actual Patient is necessary to improve the performance of the system.

Normalization of the Relational Schema

The Relational Schema derived from the transformed ER schema is already normalized up to the Boyce-Codd Normal Form (BCNF). Here follows a brief explanation.
First Normal Form (1NF): there are no multivalued or composite attributes, therefore the schema satisfies the requirements of 1NF.
Second Normal Form (2NF): all the relations in the schema have a primary key constituted of a single attribute, therefore they are in 2NF. Furthermore, the schema does not contain any key which is not a primary key and we can thus conclude that the relational schema is in 2NF.
BCNF and Third Normal Form (3NF): the schema is in BCNF since no functional dependency X-->Y occurs between the attributes of the same relation where X is not a superkey. Since BCNF implies 3NF, the schema also achieves this Normal Form.

Relational Schema

Since the Relational Schema does not fit in a single page, it is reported in two parts.
Some relations are present in both the images for the sake of clarity.

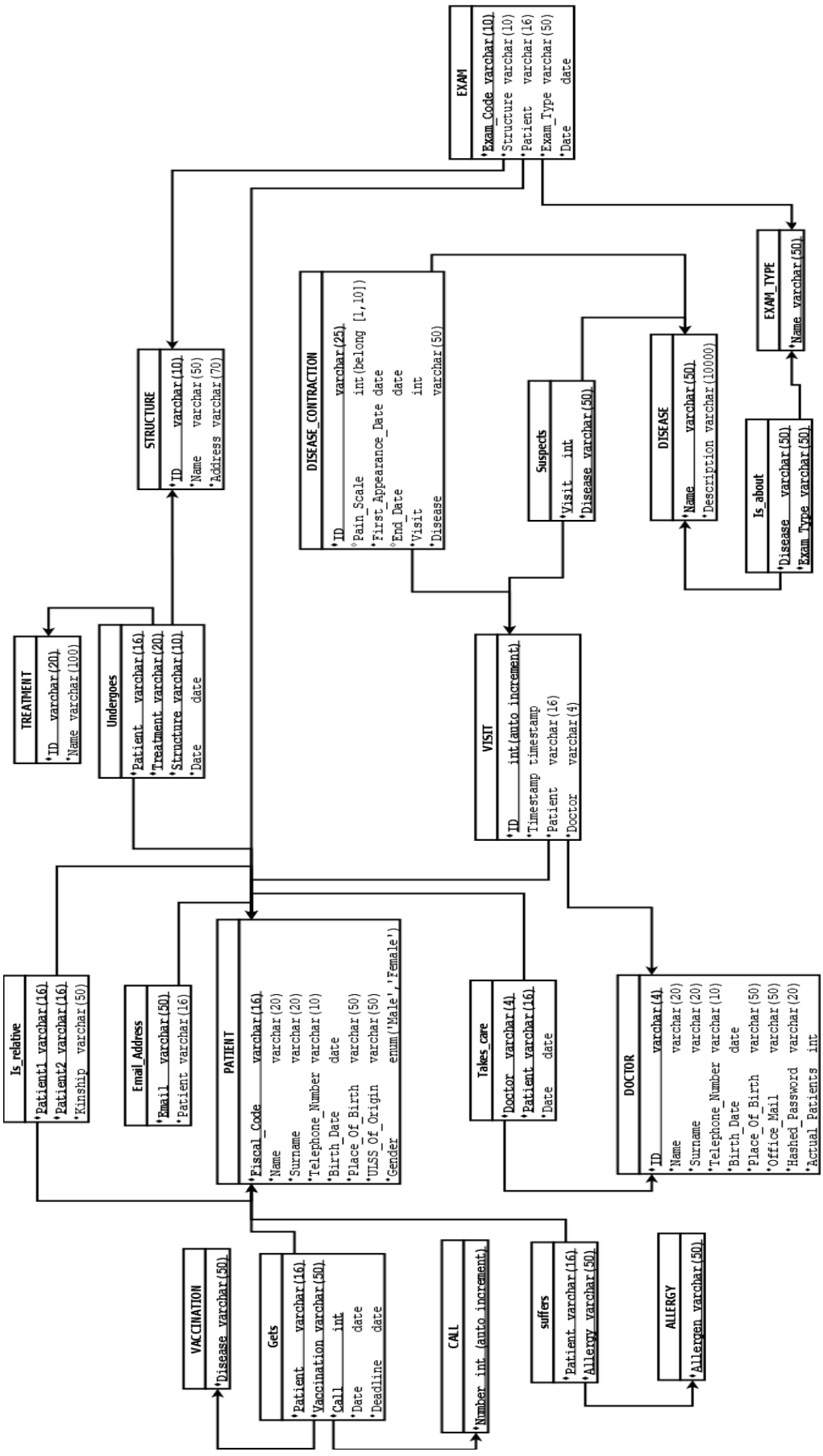


Figure 3: Relational Schema, Part 1

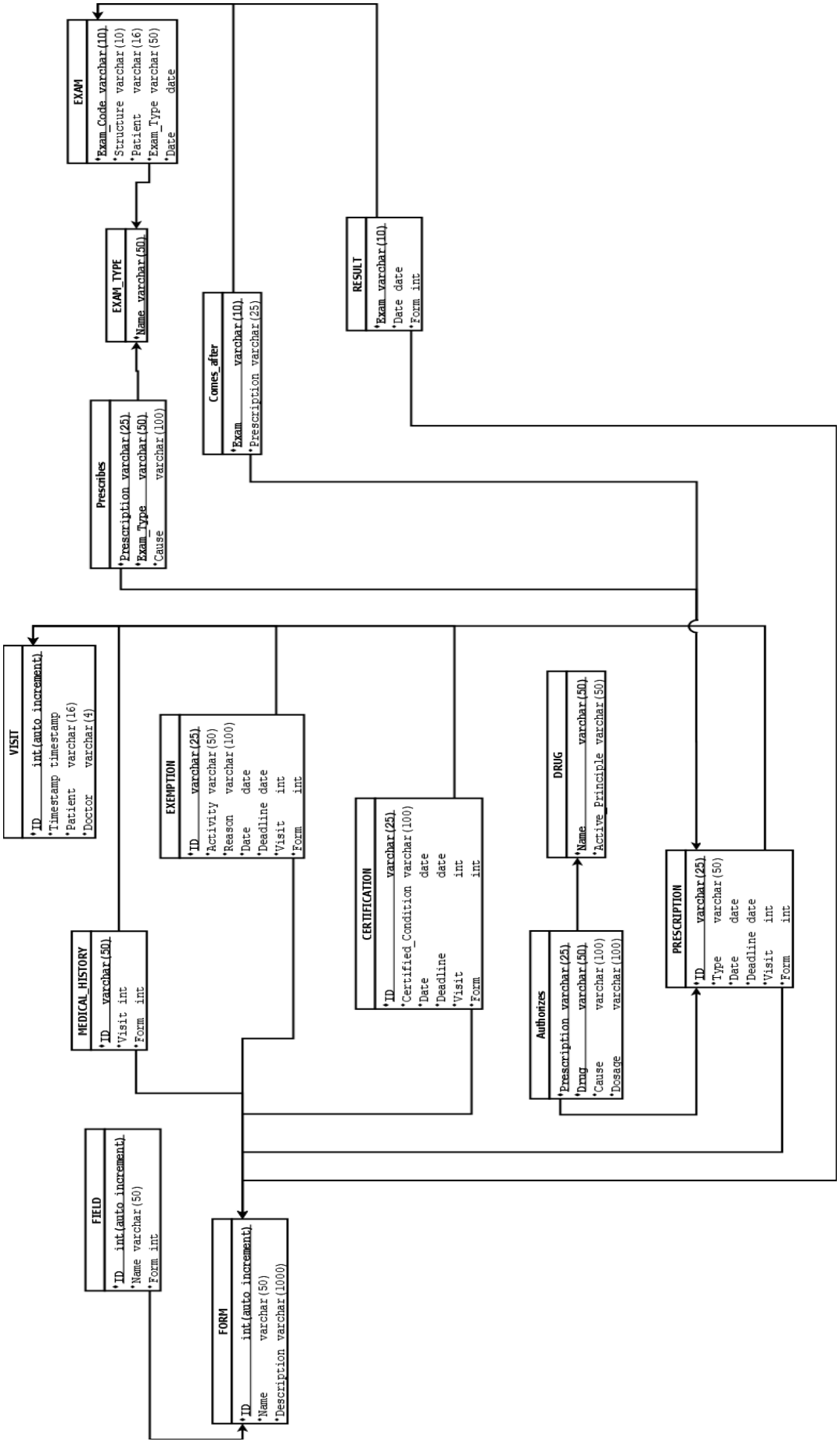


Figure 4: Relational Schema, Part 2