



Politecnico
di Torino

DBG
MG

Database design

Example

Conceptual design (1/2)

- Database design stages
- Design example: problem specifica
- Design example: main concepts
- Design example: model refinement (I)
- Design example: model refinement (II)
- Design example: model refinement (III)

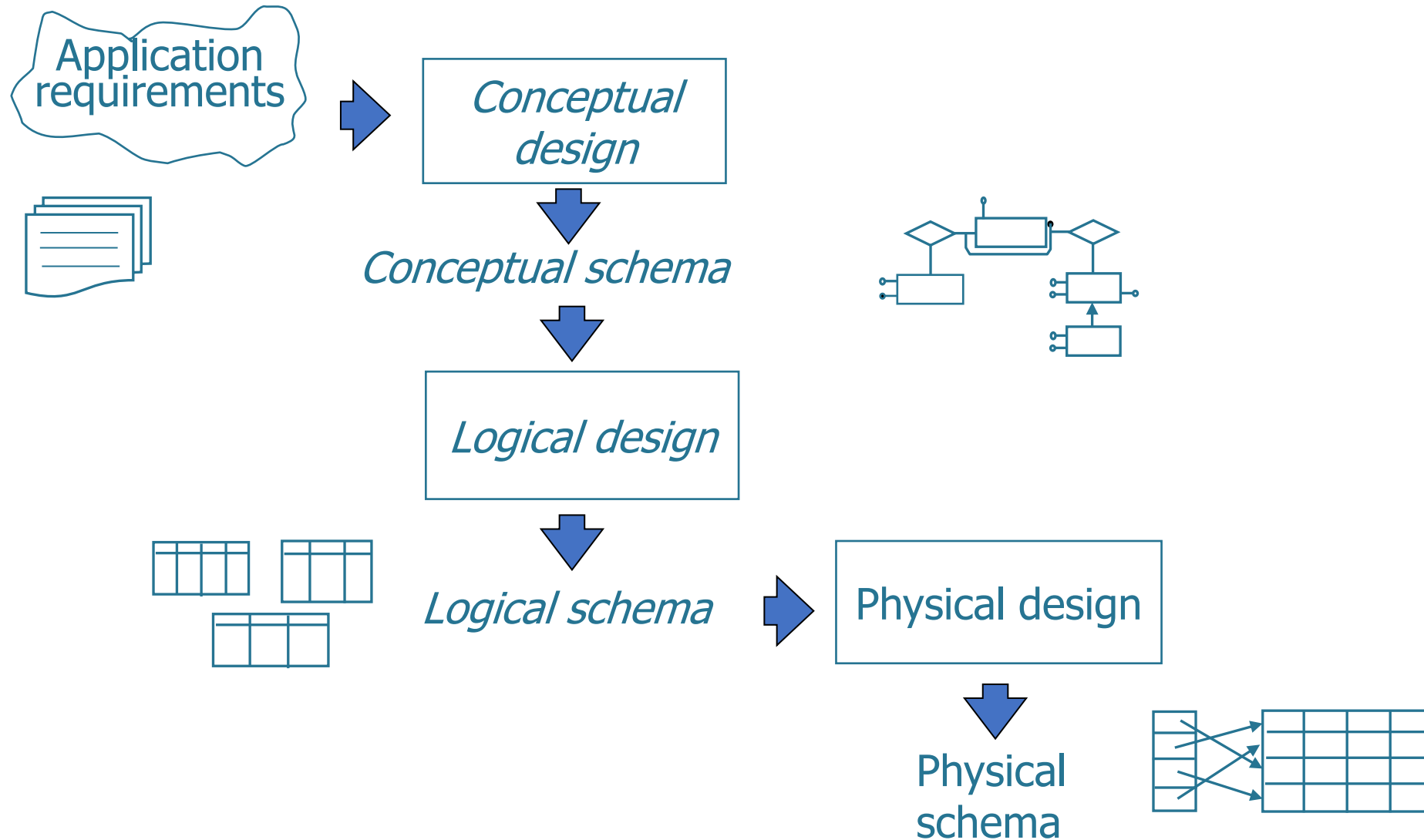
Conceptual Design (2/2)

- Design example: representation of time (I)
- Design example: representation of time (II)
- Design example: representation of time (III)

Database design

Database design stages

Database design stages



Requirements collection and analysis

- Requirements collection
 - problems that the application must solve
 - static and dynamic features of the application
- Requirements analysis
 - clarification and organization of the specifications
- Interconnected and scarcely standardizable activities

Requirements sources

- Application users
 - interviews
 - written documentation
- Existing documentation
 - regulations
 - internal rules
 - forms
- Existing systems
 - applications to replace or interact with

Requirements collection

- System users play an important role
 - high-level users have a more general view, but they often do not know the details
 - different users can provide different information (complementary or contradictory)

Requirements collection

- In practice:
 - verify that the collected information is consistent and correct
 - verify also with examples (related to general and borderline cases)
 - require precise definitions and classifications
 - distinguish the essential requirements from nice-to-have and less stringent requirements
 - proceed through subsequent refinements

Requirements analysis

- In practice:
 - choose the right abstraction level
 - standardize the structure of the sentences
 - avoid convoluted sentences
 - identify synonyms/homonyms and unify the terms
 - make explicit all references between terms
 - build a glossary of terms

Conceptual design

- Various project strategies have been proposed
- The most effective strategy is hybrid
 - the basic concepts are identified (the most relevant entities and relationships)
 - the initial project is progressively refined by adding the attributes, the cardinality of the relationships, the hierarchies, other entities and relationships
- If the problem is highly complex, it can be broken down into subproblems to solve separately and integrate later

Conceptual design: general criteria

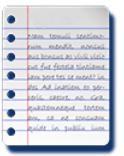
- If a concept has significant properties or describes classes of objects with autonomous existence
 - entity
- If a concept has a simple structure and has no relevant properties
 - attribute (possibly multivalued)
- If two or more concepts are related
 - relation
- If a concept is a particular case of another one
 - hierarchy

Quality of a conceptual scheme

- Correctness
 - use of appropriate model constructs
 - absence of syntactic and semantic errors
- Completeness
 - representation of all the concepts of interest
- Minimality
 - every requirement is represented only once in the schema
 - all redundancies are verified and documented
- Legibility

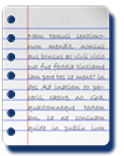
Database design

Problem requirements



Problem requirements

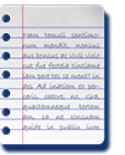
- We want to represent a database for the management of a medical examination booking system within a Local Health Authority (ASL), considering the following information.
- Each patient is characterized by the health card number, name, surname, address, date of birth, place of birth and age.
- ASL hospitals are characterized by a numerical code, name and address.



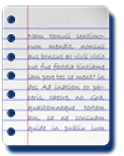
Problem requirements

- Each hospital is divided into departments identified by a unique numeric code within the hospital and characterized by department name and telephone number.
- The department staff is identified by a Social Security Number (SSN). Name, surname and address are also known.
- Among the staff, for doctors the list of specializations achieved is known and for the volunteers the name of the association they belong to (if available) is stored.

Problem requirements

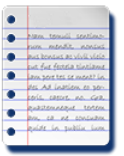


- The medical examinations that can be performed are characterized by a numerical code and a textual description (e.g., X-ray exam, etc.).
- For specialistic examinations, the doctor who carries out the visit and a description of the diet to follow (if necessary) are also stored.
- The laboratories that perform the examinations are identified by a unique code within the hospital and they are characterized by the name of the laboratory, the location plan and the room number.



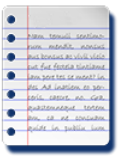
Problem requirements

- For each member of the laboratory staff, the days and laboratories in which he/she works are stored. Pay attention to the fact that during the same day each staff member can work in more than one laboratory.



Problem requirements

- Each exam requires a reservation. For each exam reservation made by a patient, the date and time of the exam, the laboratory where it is performed, the cost of the ticket and the information about the exam being urgent or not are stored.
- Please note that each patient can make multiple reservations for the same exam on different dates and the same exam cannot be repeated on the same day by the same patient, even in different laboratories.



Problem requirements

- Each doctor can take on different roles during his/her career (e.g. assistant, head physician, etc.). We want to keep track of the roles each doctor has taken on during his/her career and the related time periods (start date, end date).
- Keep in mind that each doctor cannot take on more than one role at the same time, but he/she can take on the same role in different time periods.

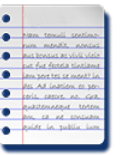
Database design

Main concepts

Main concepts identification

- Text analysis to identify the most important concepts
 - the main entities of the ER diagram
 - any links between entities

Patient Concept

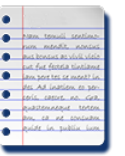


- Each *patient* is characterized by health card number, name, surname, address, date of birth, place of birth and age.

Patient Concept

Patient

Hospital concept



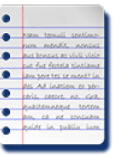
- ASL *hospitals* are characterized by a numeric code, a name and an address.

Hospital concept

Patient

Hospital

Department concept



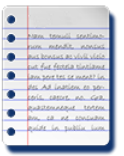
- Each hospital is divided into *departments* identified by a unique numeric code within the hospital and characterized by the department name and the telephone number.

Department concept

Patient

Hospital

Department



Staff concept

- The *department staff* is identified by a Social Security Number (SSN).
- Name, surname and address are also known.
- Among the staff, for **doctors** the list of specializations achieved is known and for the **volunteers** the name of the association they belong to (if available) is stored.

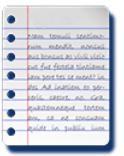
Staff concept

Patient

Staff

Hospital

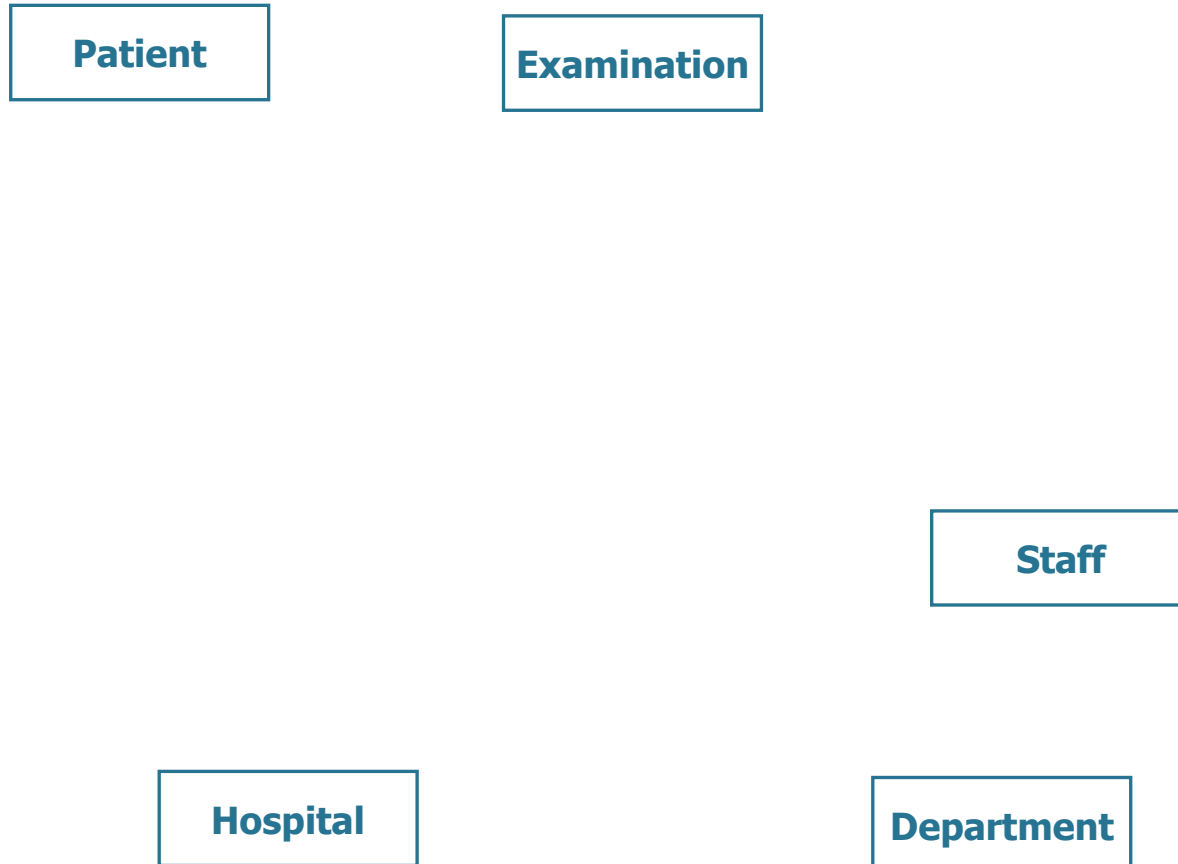
Department



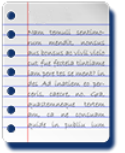
Examination concept

- The *medical examinations* that can be performed are characterized by a numerical code and a textual description (e.g. X-ray exam, etc.).
- For specialist examinations, the doctor who carries out the visit and a description of the diet to follow (if necessary) are also stored.

Examination concept



Laboratory concept



- The *laboratories* that perform the tests are identified by a unique code within the hospital and are characterized by the name of the laboratory, the location plan and the room number.

Laboratory concept

Patient

Examination

Laboratory

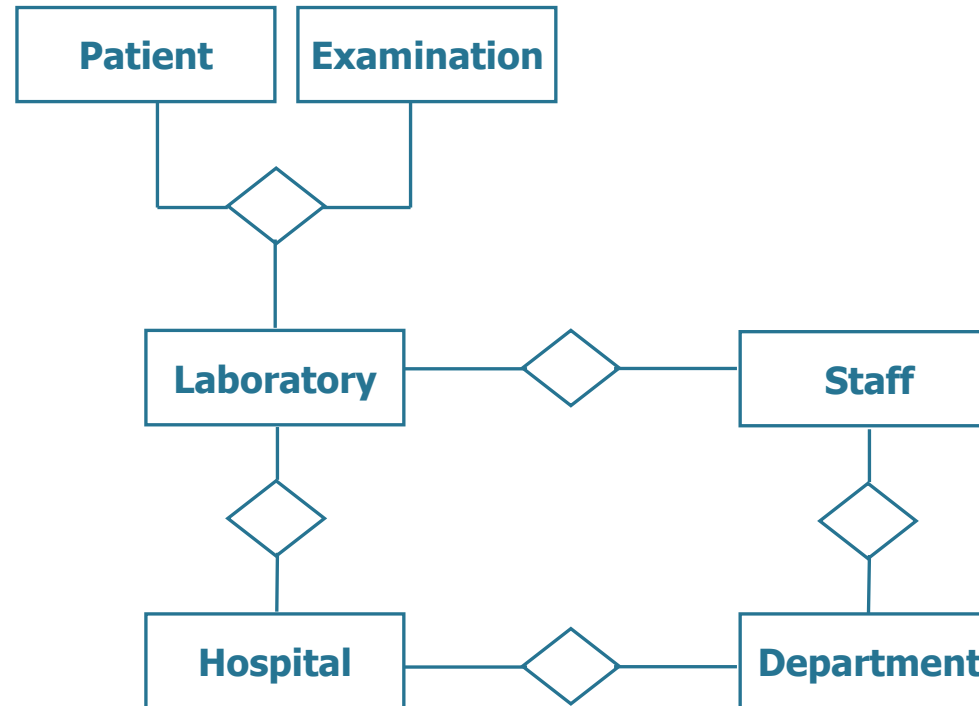
Staff

Hospital

Department

Main concepts

- Main concepts
 - patient
 - examination
 - laboratory
 - hospital
 - department
 - staff

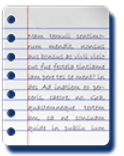


Database design

Model refinement (I)

Concepts refinement

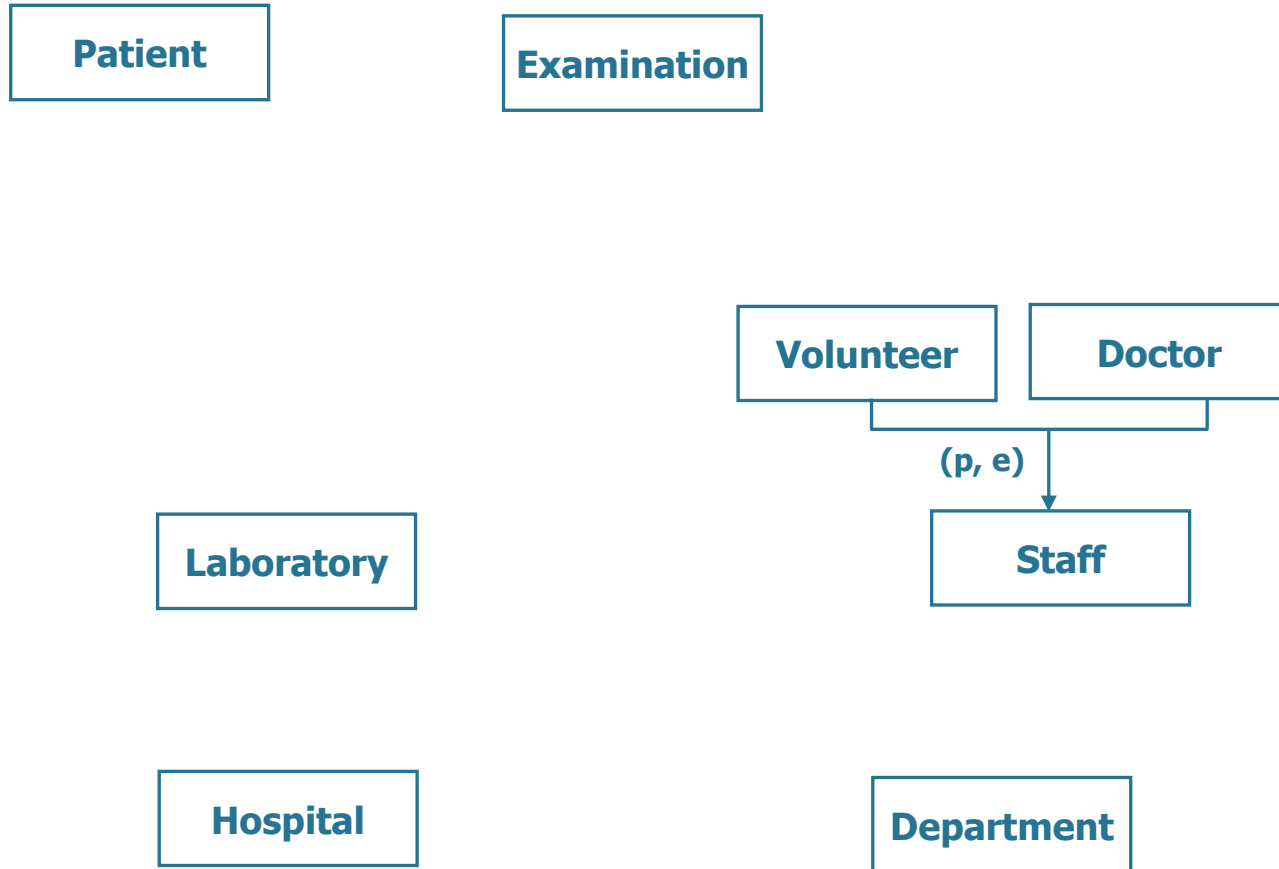
- Refinement of concepts
 - introduction of hierarchies
 - attributes definition
 - characterization of relationships with cardinality



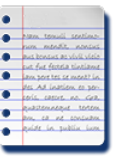
Staff hierarchy

- The department staff is identified by a Social Security Number (SSN). Name, surname and home address are also known.
- Among the staff, for *doctors* the list of specializations achieved is known and for the *volunteers* the name of the association they belong to (if available) is stored.

Staff hierarchy

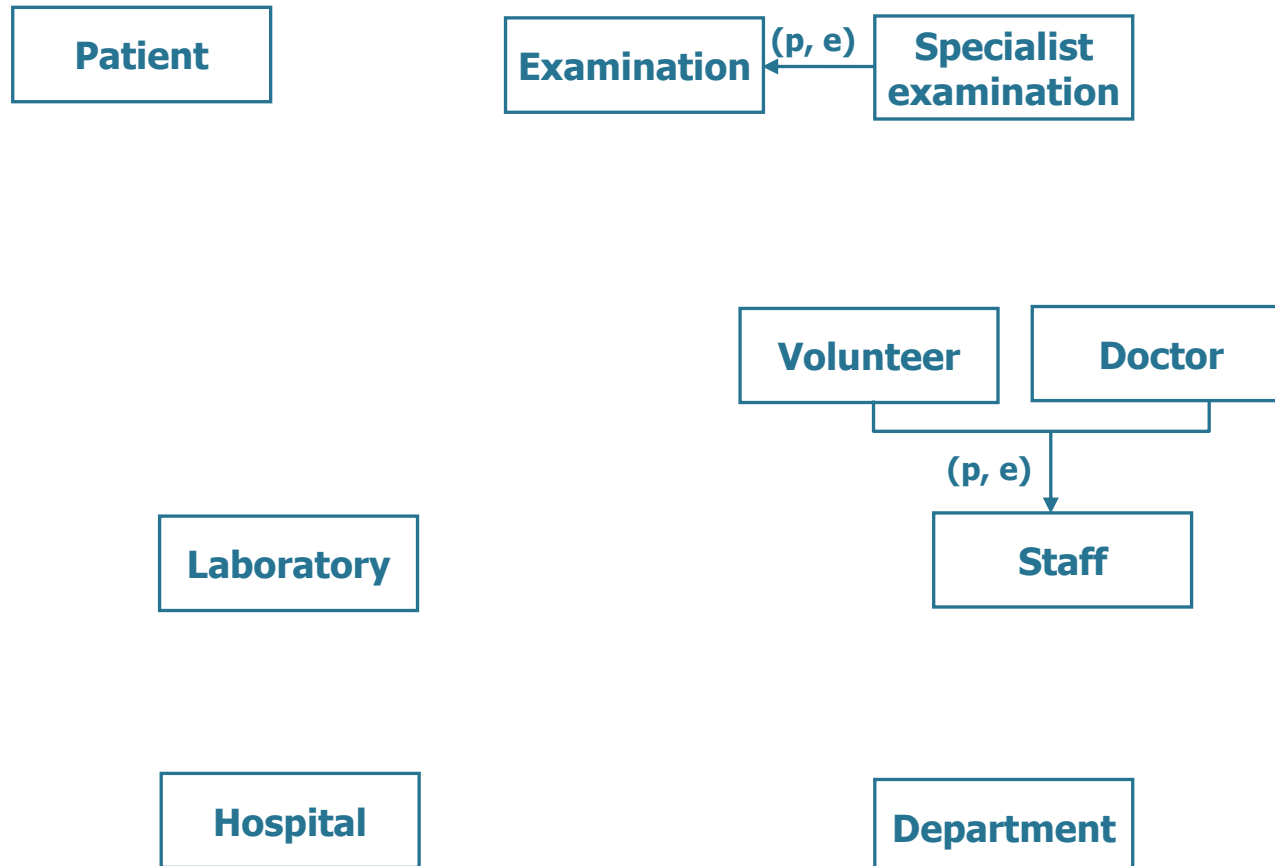


Exam hierarchy



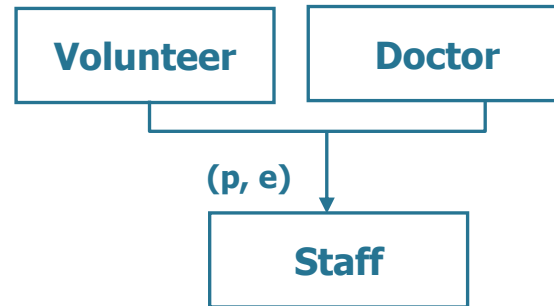
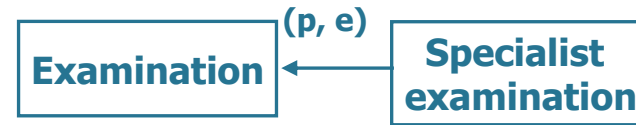
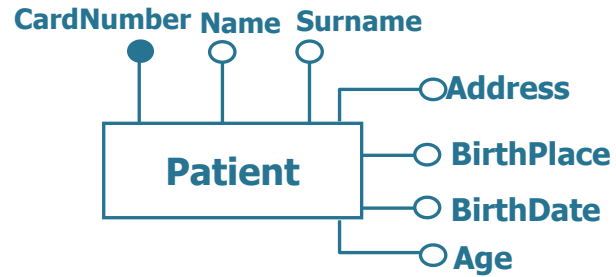
- The medical examinations that can be performed are characterized by a numerical code and a textual description (e.g. radiography, etc.). For *specialist examinations*, the doctor who carries out the visit and a description of the diet to follow (if necessary) are also stored.

Exam hierarchy



Refinement of the Patient entity

Each patient is characterized by health card number, name, surname, address, date of birth, place of birth and age.

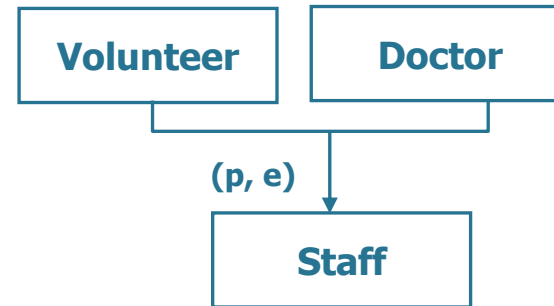
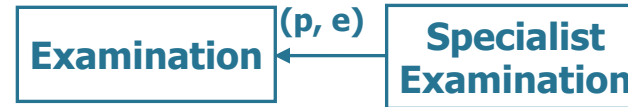
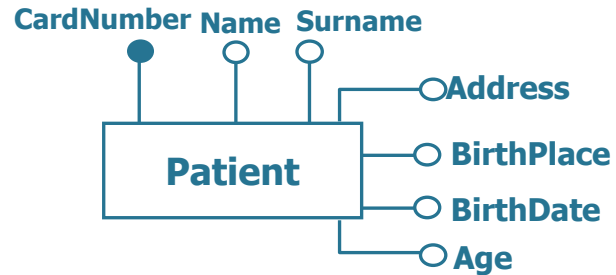


Date of birth and Age Attributes

- The Age attribute is redundant because it can be easily calculated starting from the date of birth (BirthDate)
- This information must be attached to the conceptual model documentation
 - Age derivation rule from BirthDate: $\text{Age} = \text{Year}(\text{Today}()) - \text{BirthDate}$
- Elimination of the Age attribute will be evaluated during the restructuring phase of the ER scheme

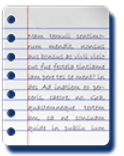
Refinement of the Hospital entity

ASL hospitals are characterized by a numerical code, name and address.



Database design

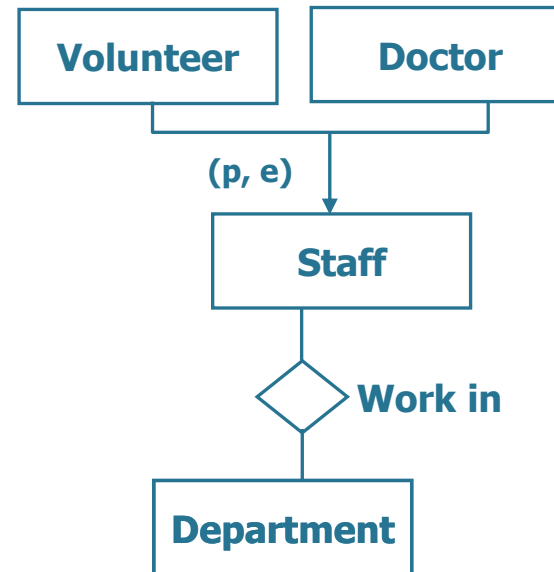
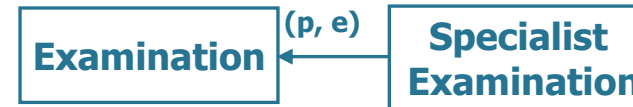
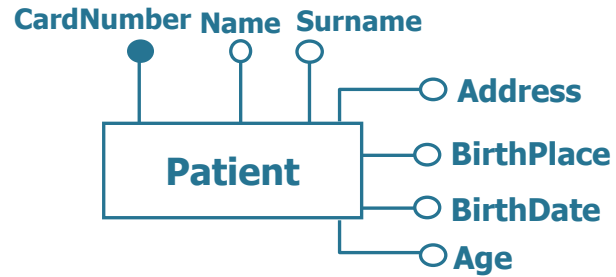
Model refinement (II)



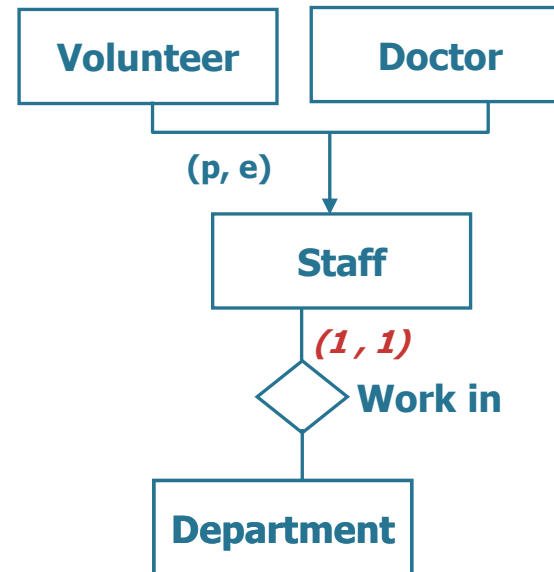
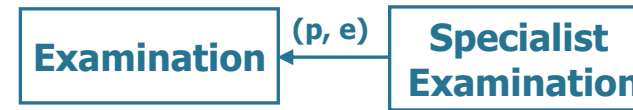
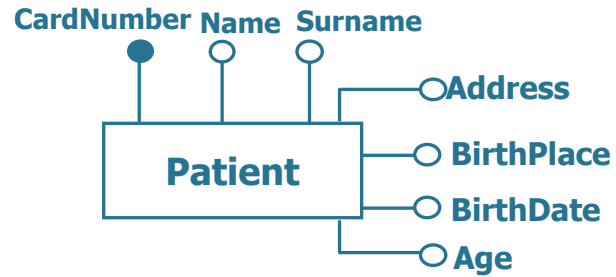
Relationship between staff and department

- *The department staff is identified by a Social Security Number (SSN). Name, surname and address are also known. Among the staff, for doctors the list of specializations achieved is known and for volunteers the name of the association they belong to (if available) is stored.*

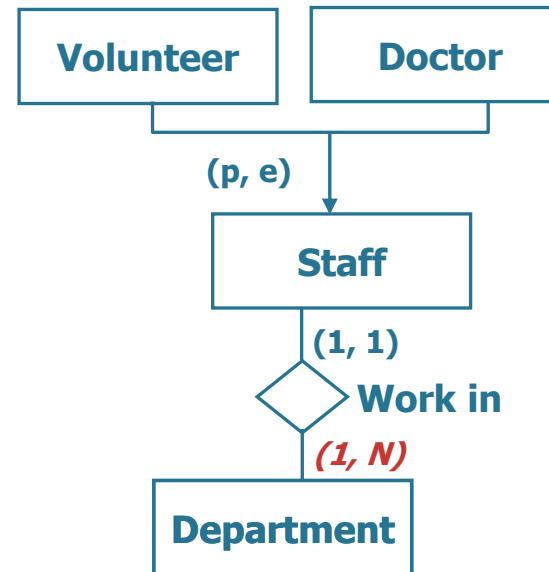
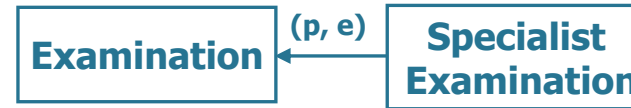
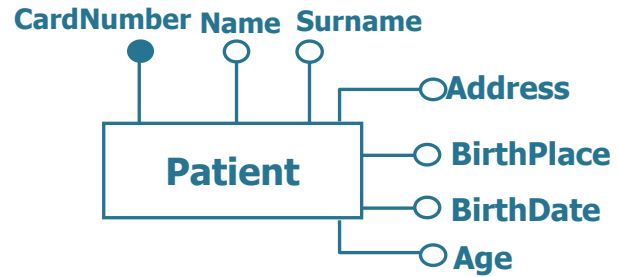
Relationship between staff and department



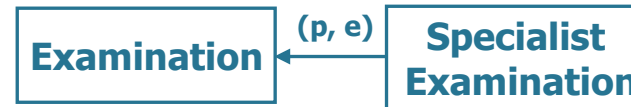
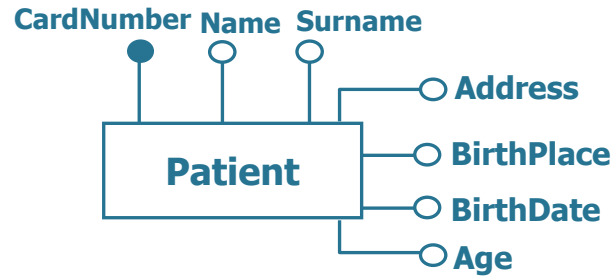
Cardinality of the *work in* Relationship



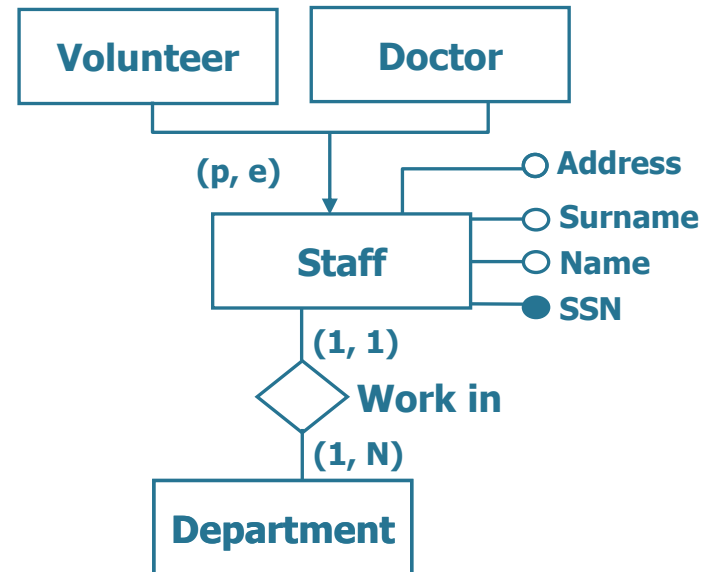
Cardinality of the *work in* Relationship



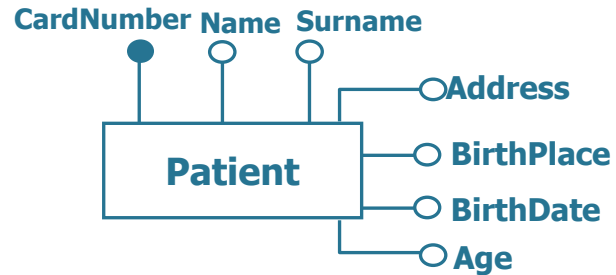
Refinement of the Staff entity



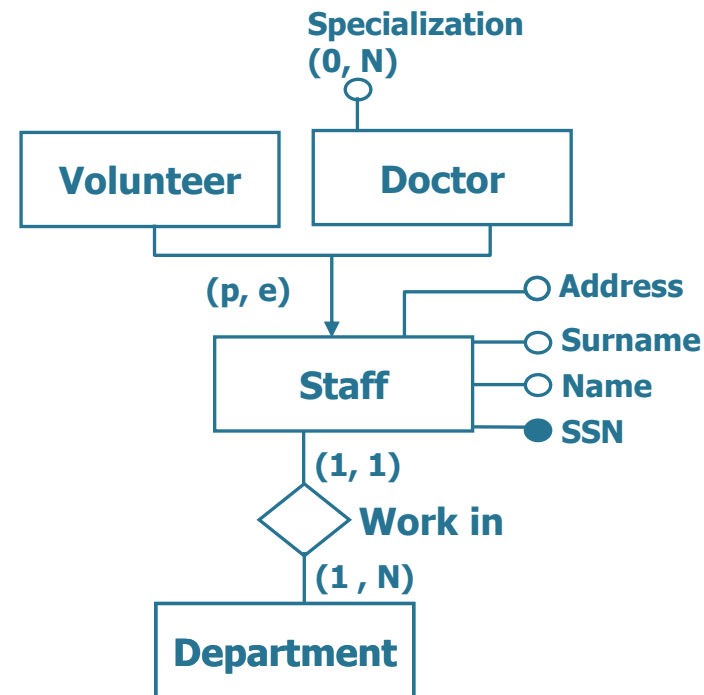
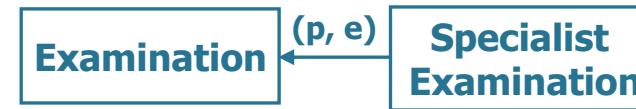
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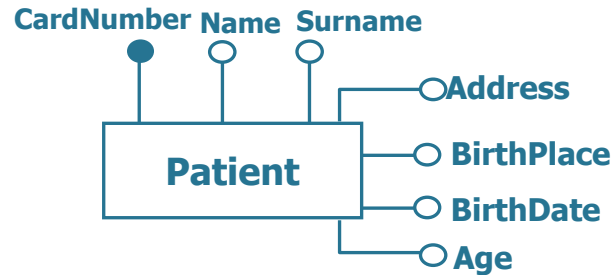
Refinement of the Doctor and Volunteer entities



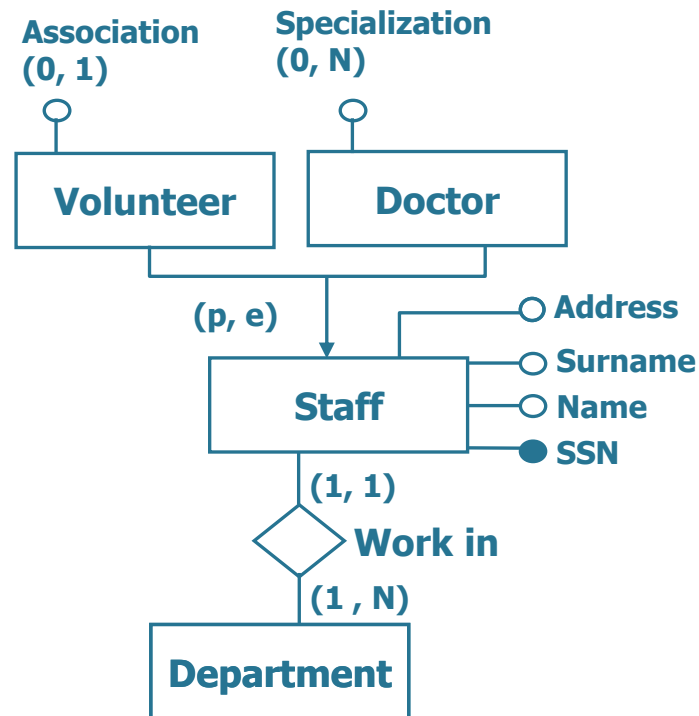
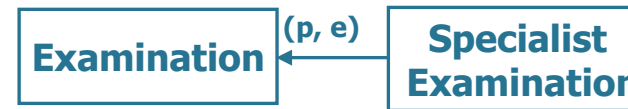
Among the staff, for doctors the list of specializations achieved is known and for volunteers the name of the association they belong to (if available) is stored.



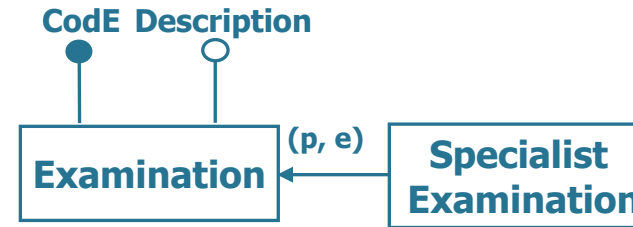
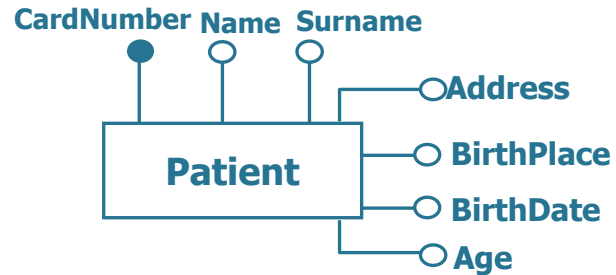
Refinement of the Doctor and Volunteer entities



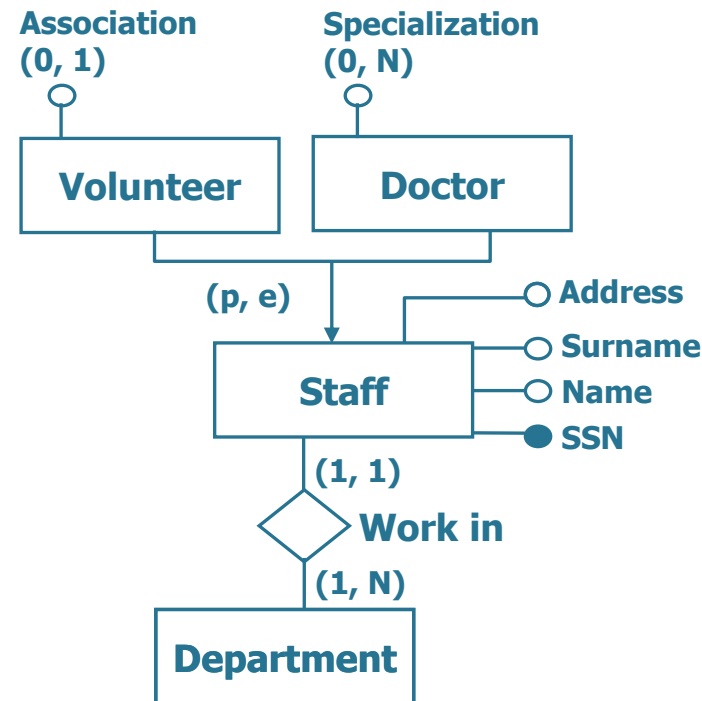
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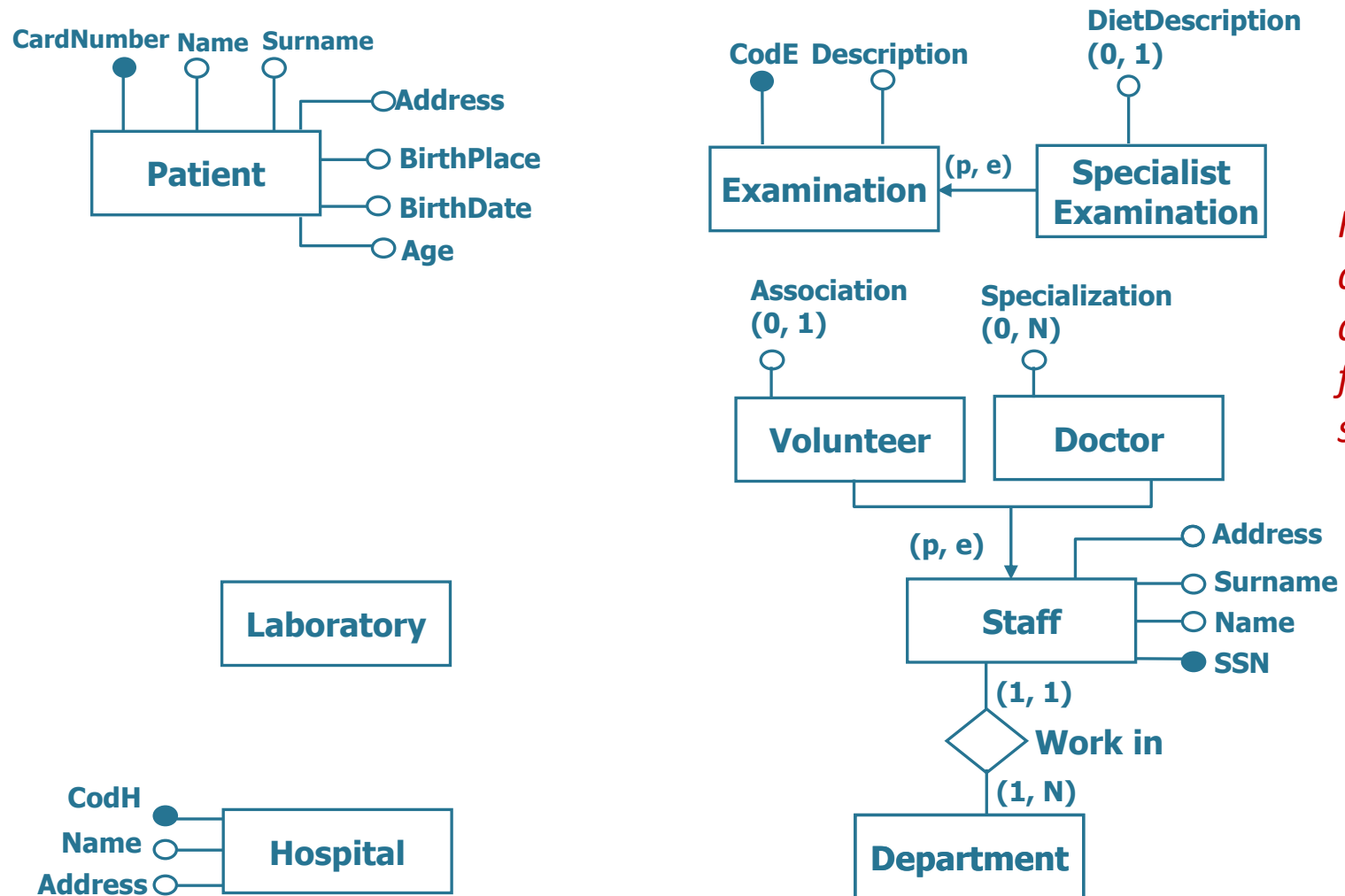
Refinement of the Examination entity



The medical examinations that can be performed are characterized by a numerical code and a textual description (e.g. X-ray exam, etc.).

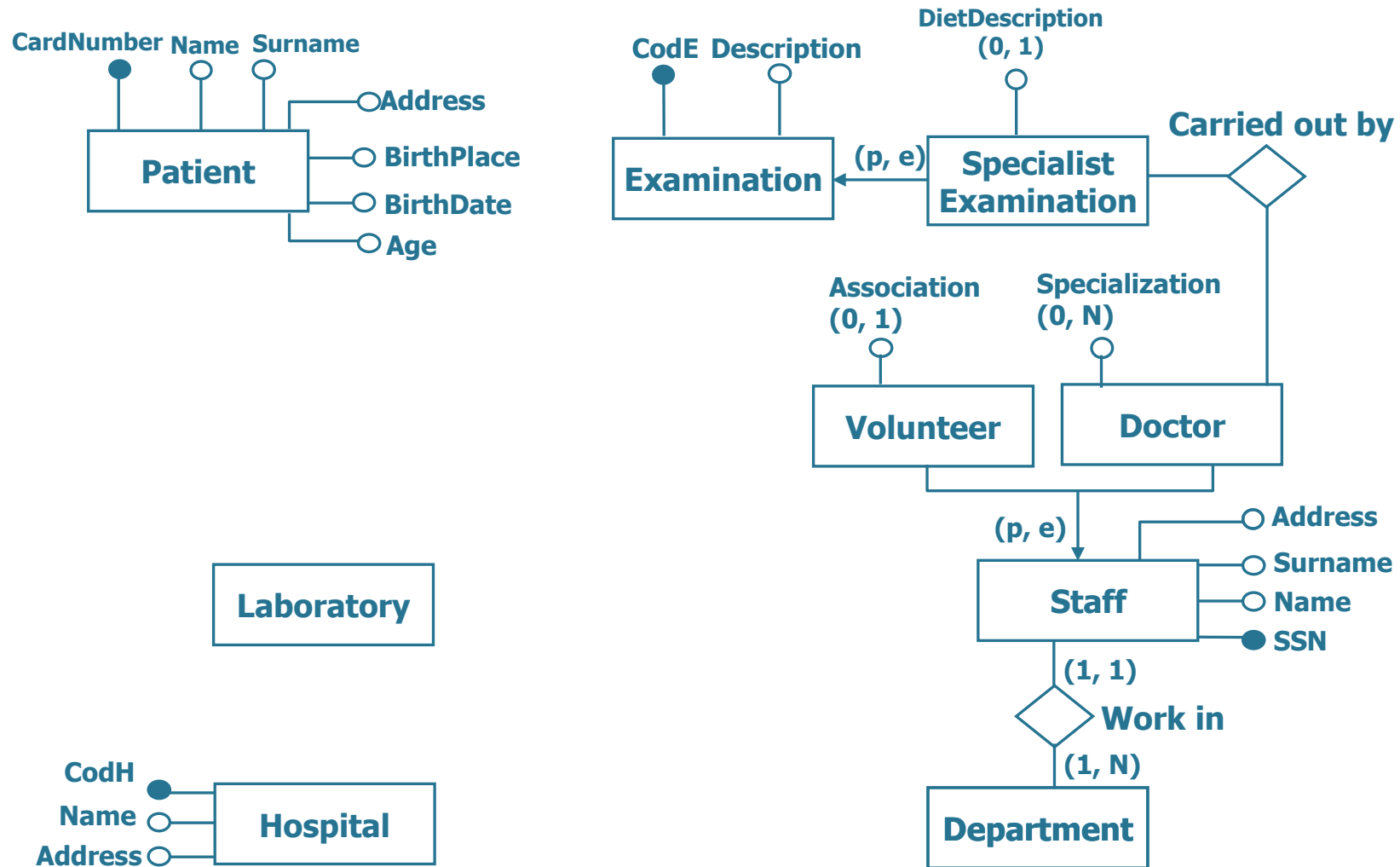


Refinement of the Specialistic Examination entity

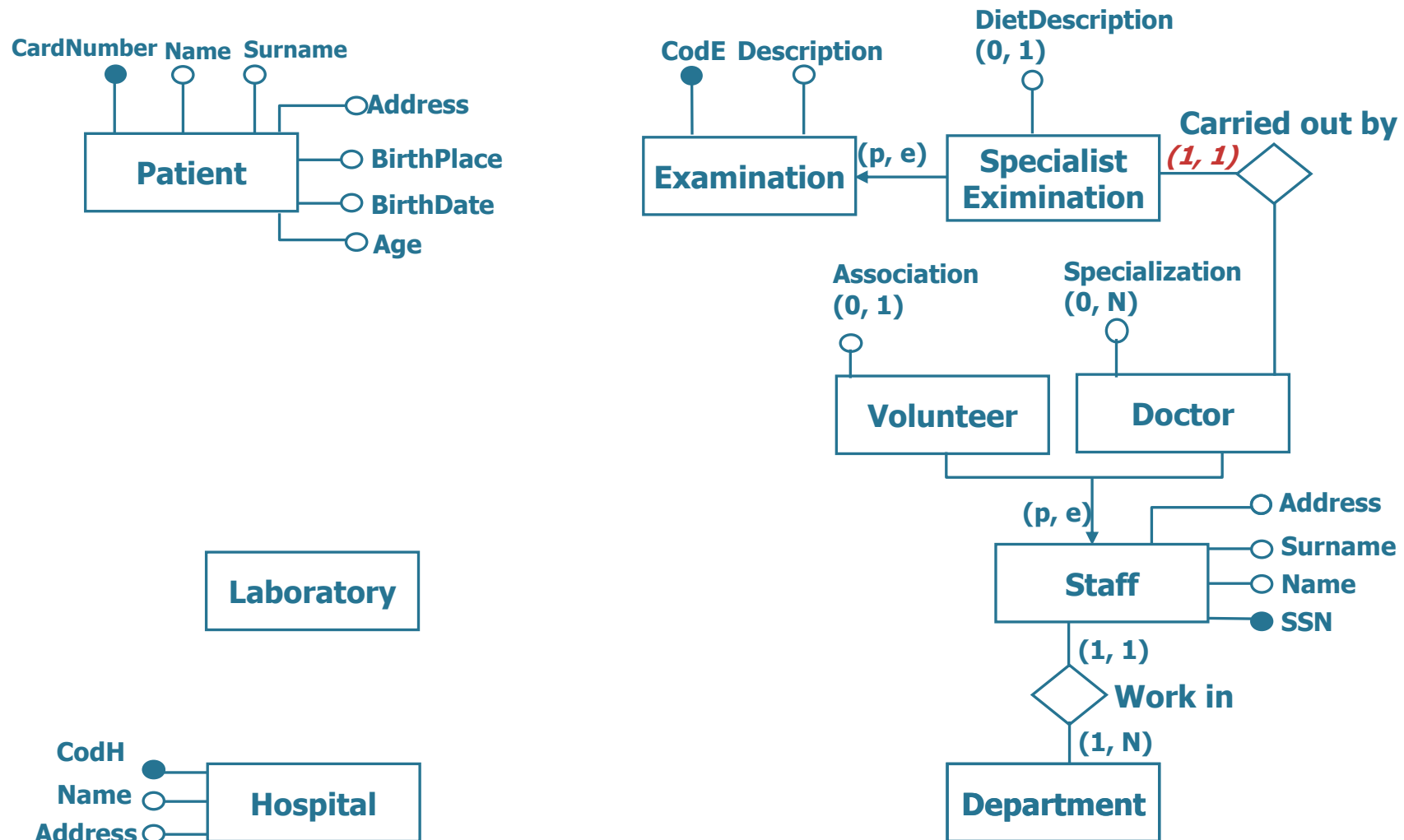


For specialist examinations, the doctor who carries out the visit and a description of the diet to follow (if necessary) are also stored.

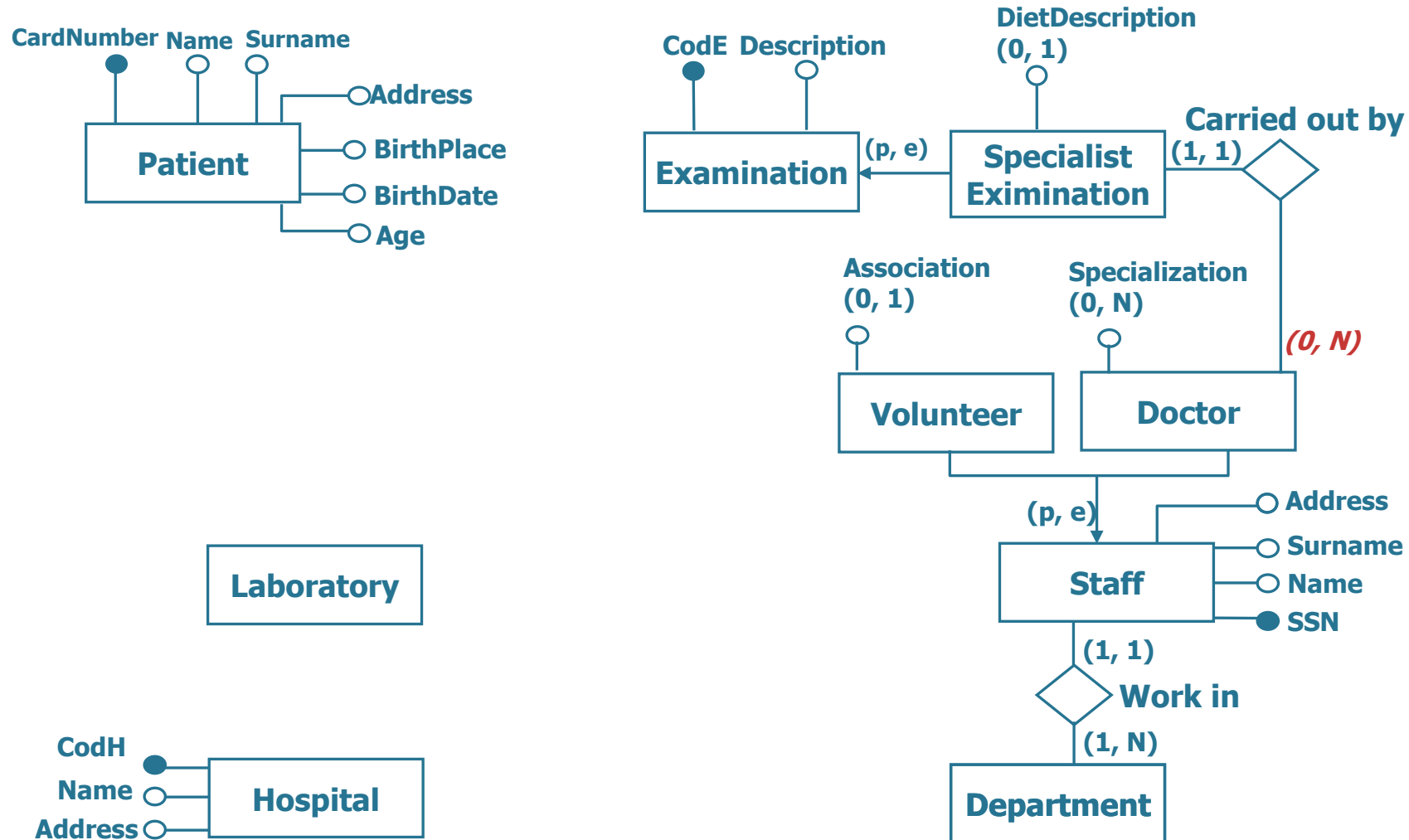
Refinement of the Specialistic Examination entity



Cardinality of the *Carried out by* relationship



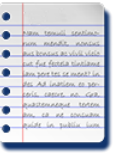
Cardinality of the *Carried out by* relationship



Database design

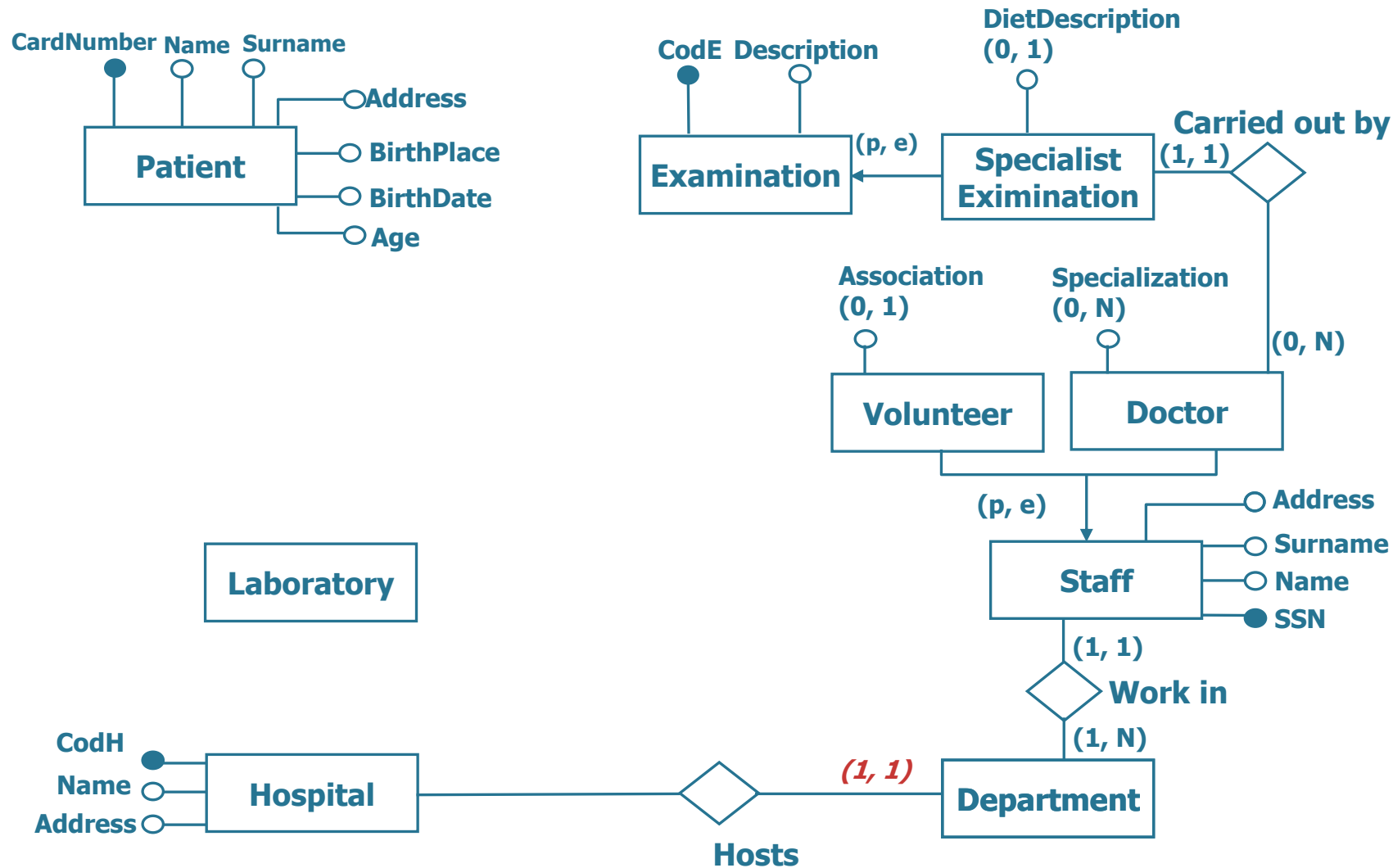
Model refinement (III)

Relationship between Department and Hospital

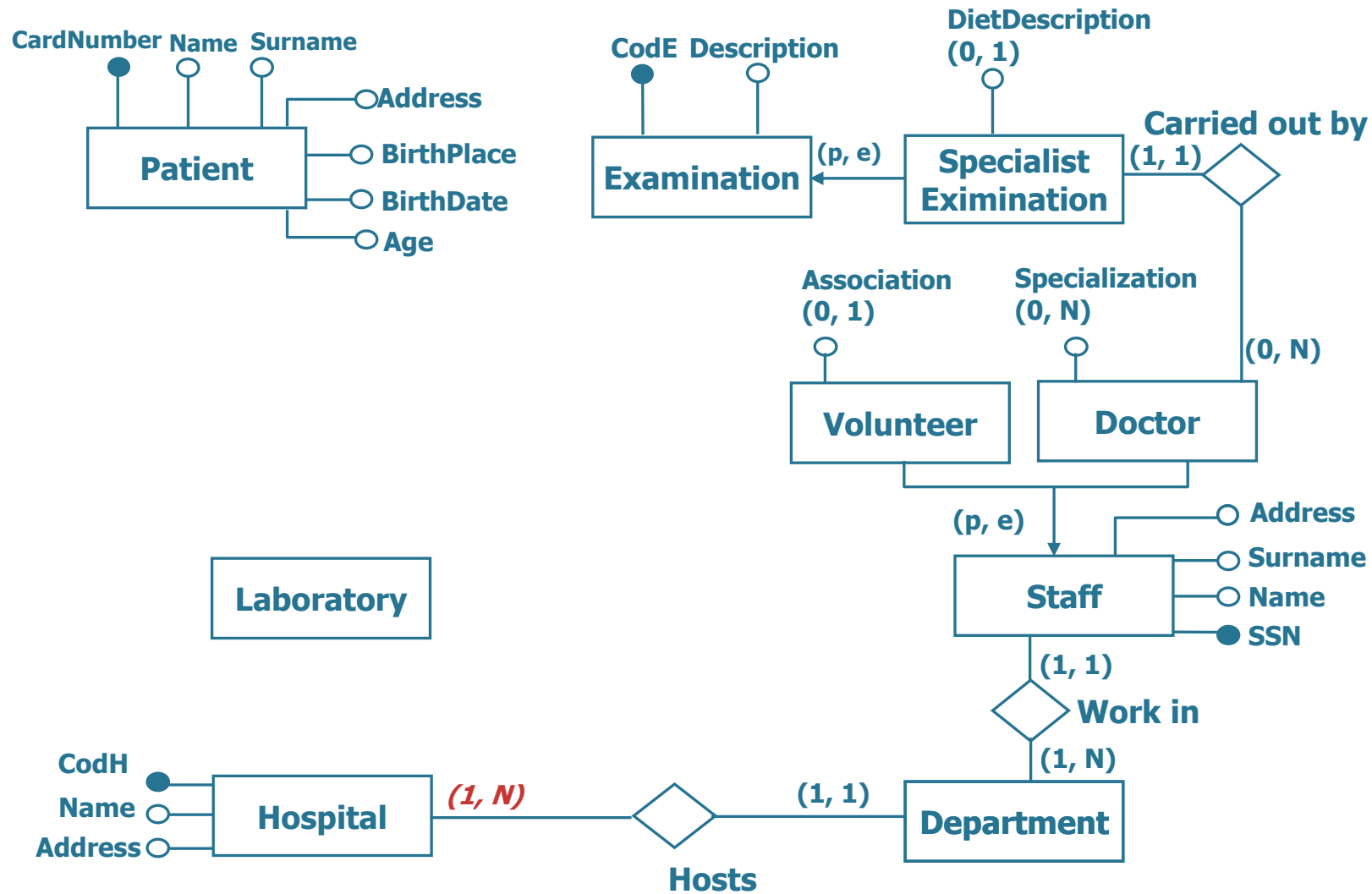


- Each hospital is divided into departments identified by a unique numeric code within the hospital and characterized by the department name and the telephone number.

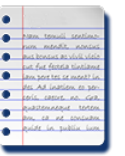
Cardinality of the *Hosts* relationship



Cardinality of the *Hosts* relationship

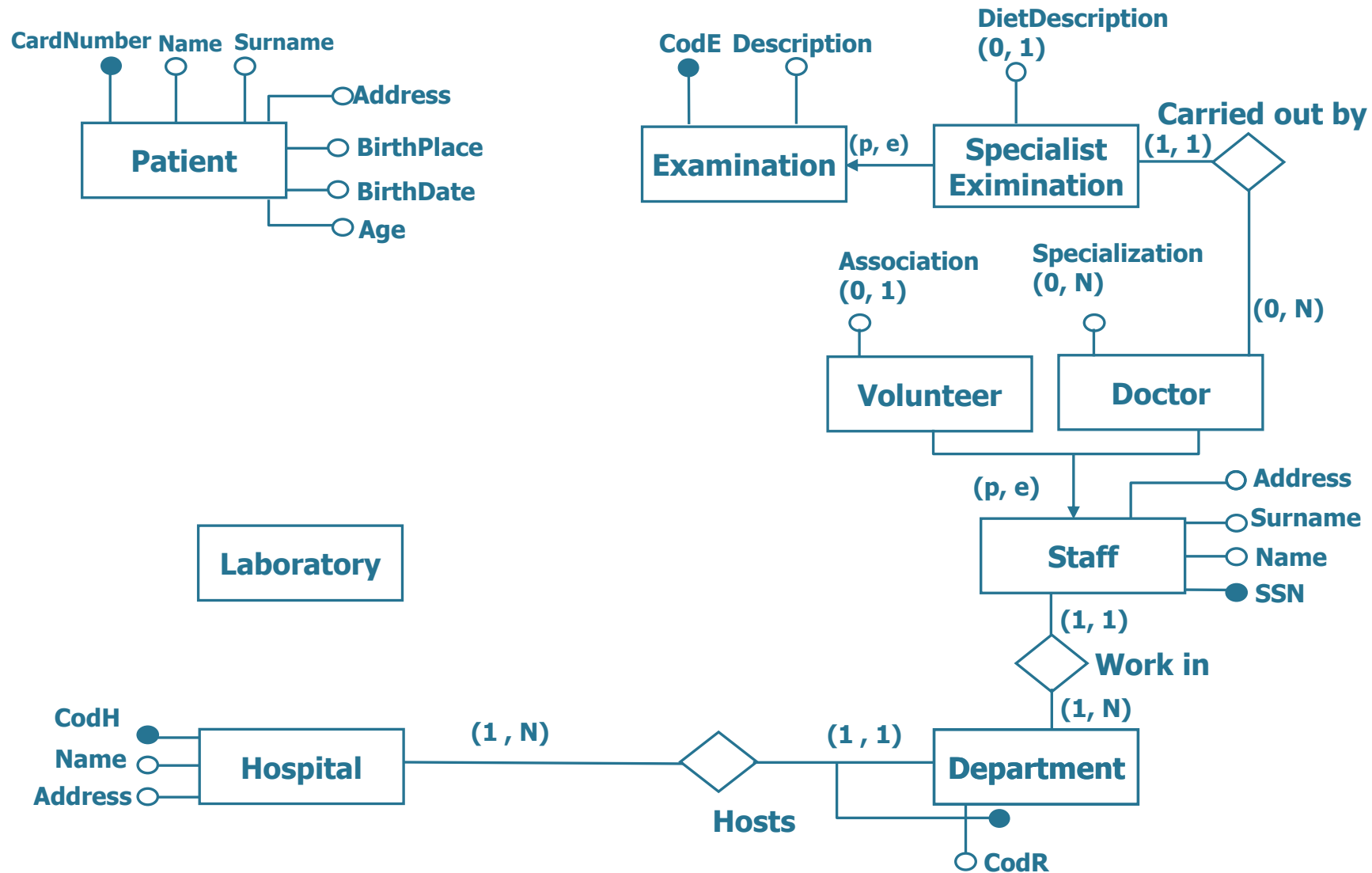


Department entity identifier

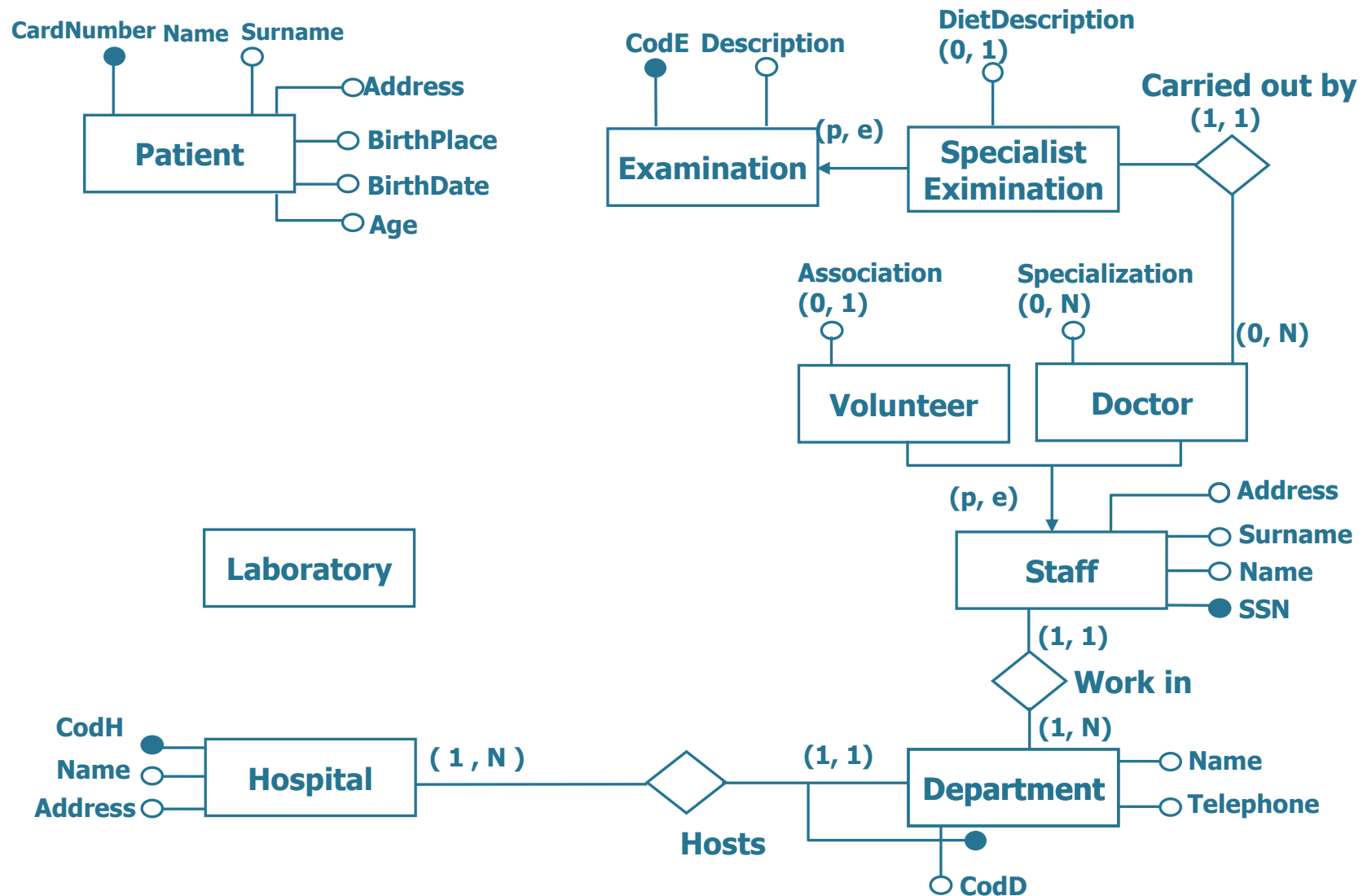


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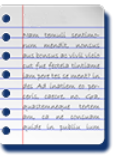
Department entity identifier



Refinement of the Department entity

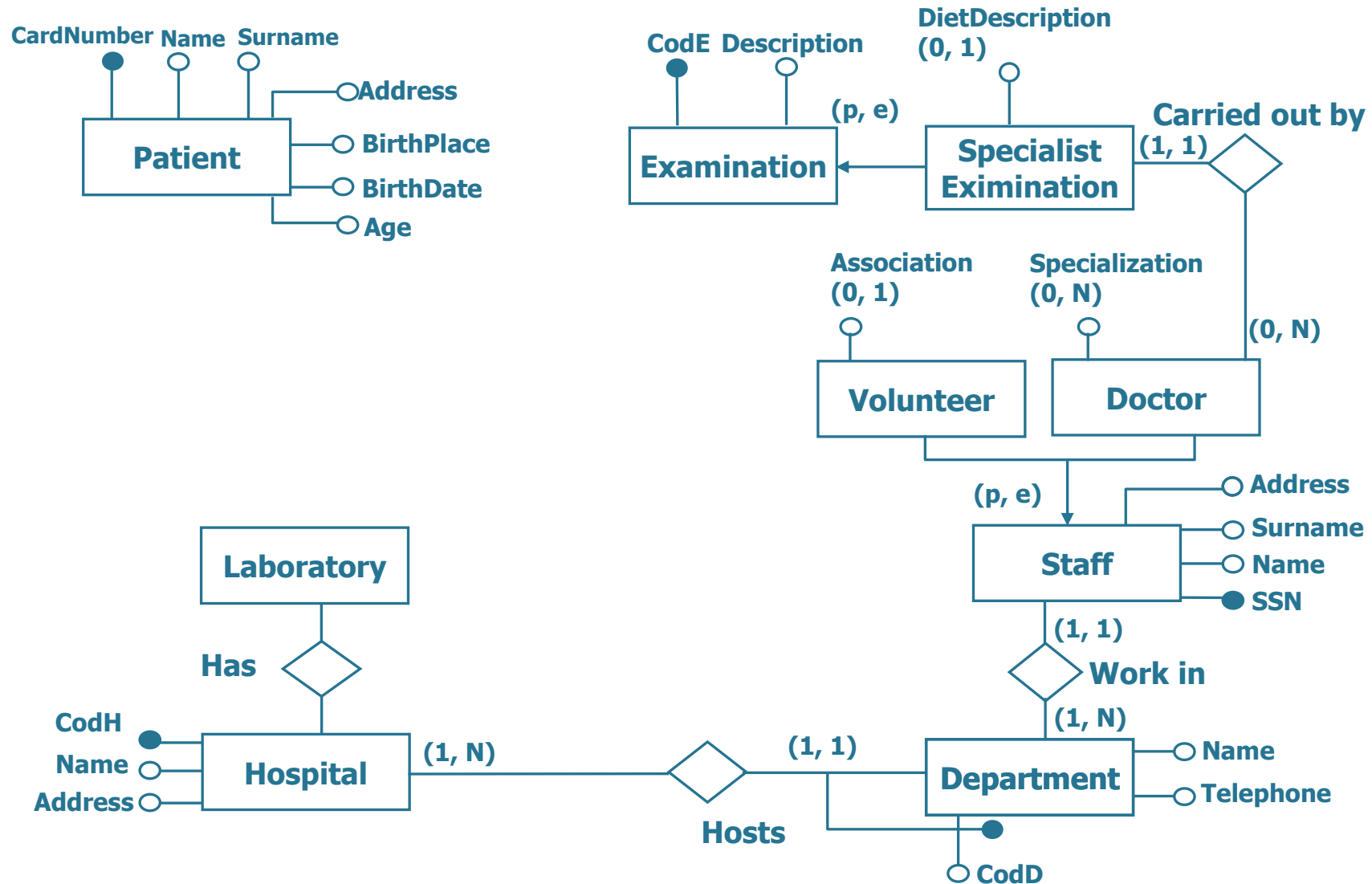


Relationship between Laboratory and Hospital

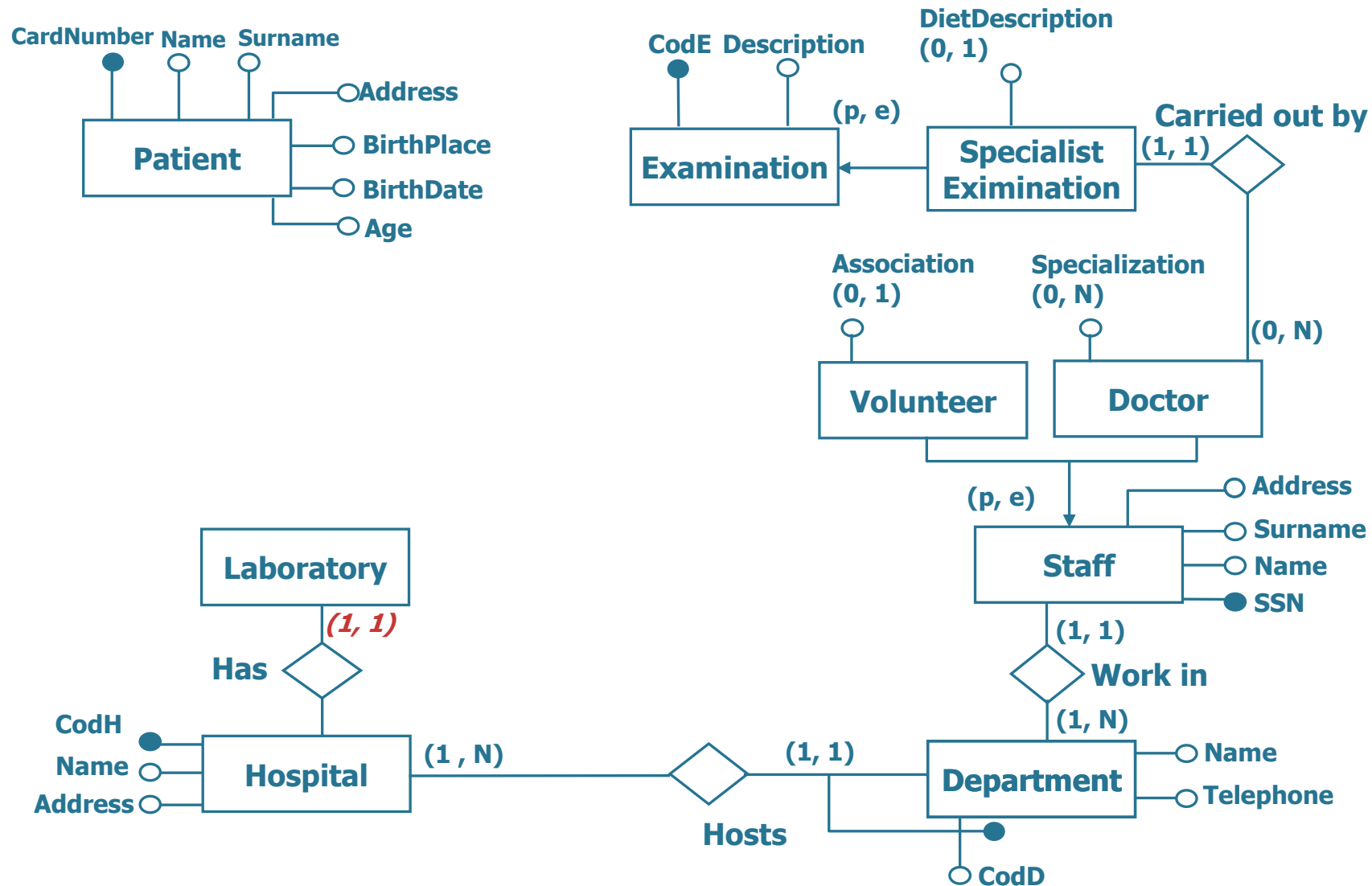


- The laboratories that perform the tests are identified by a unique code within the hospital and are characterized by the name of the laboratory, the location plan and the room number.

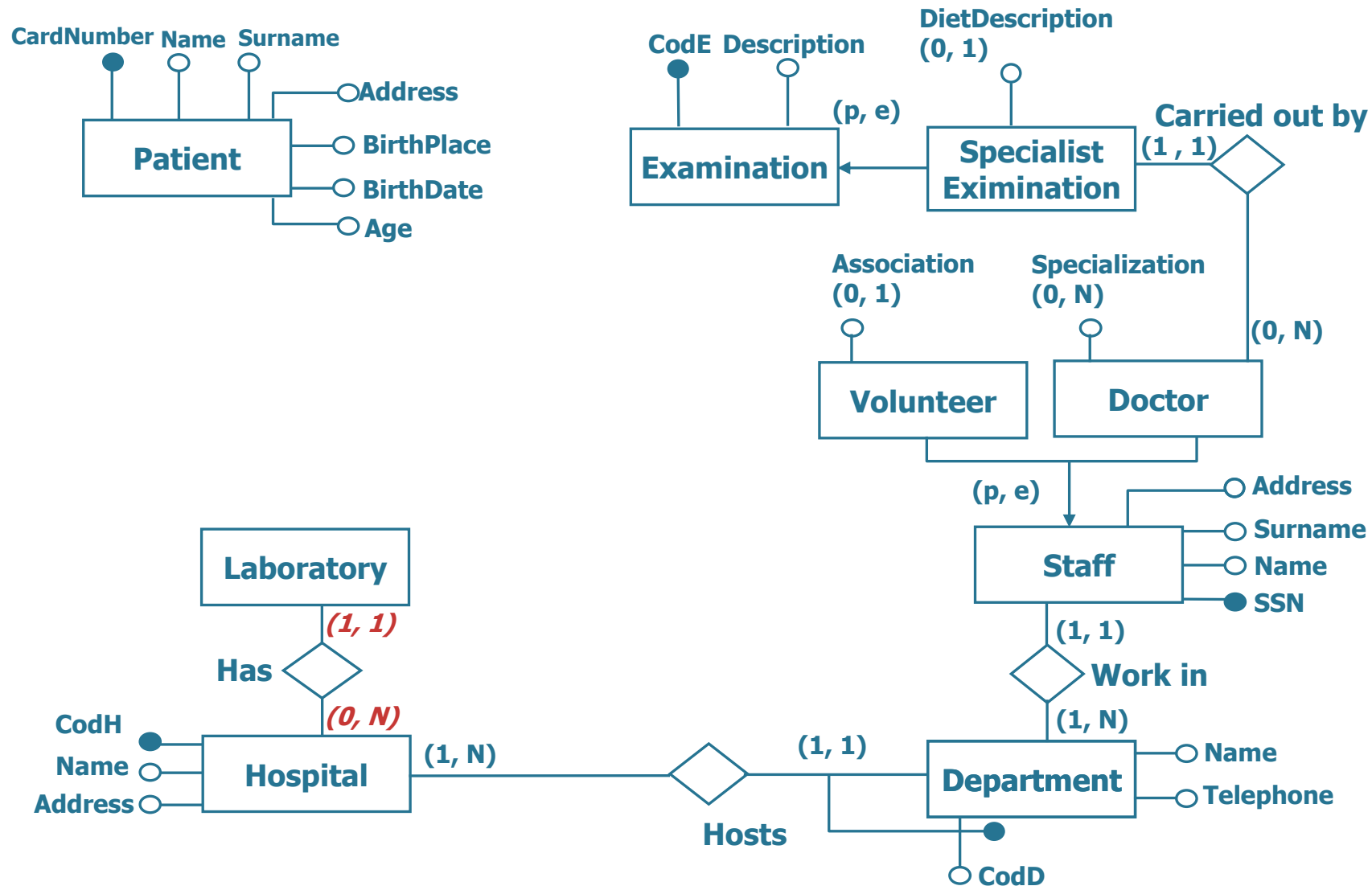
Relationship between Laboratory and Hospital



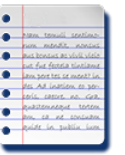
Cardinality of the *Has* relationship



Cardinality of the *Has* relationship

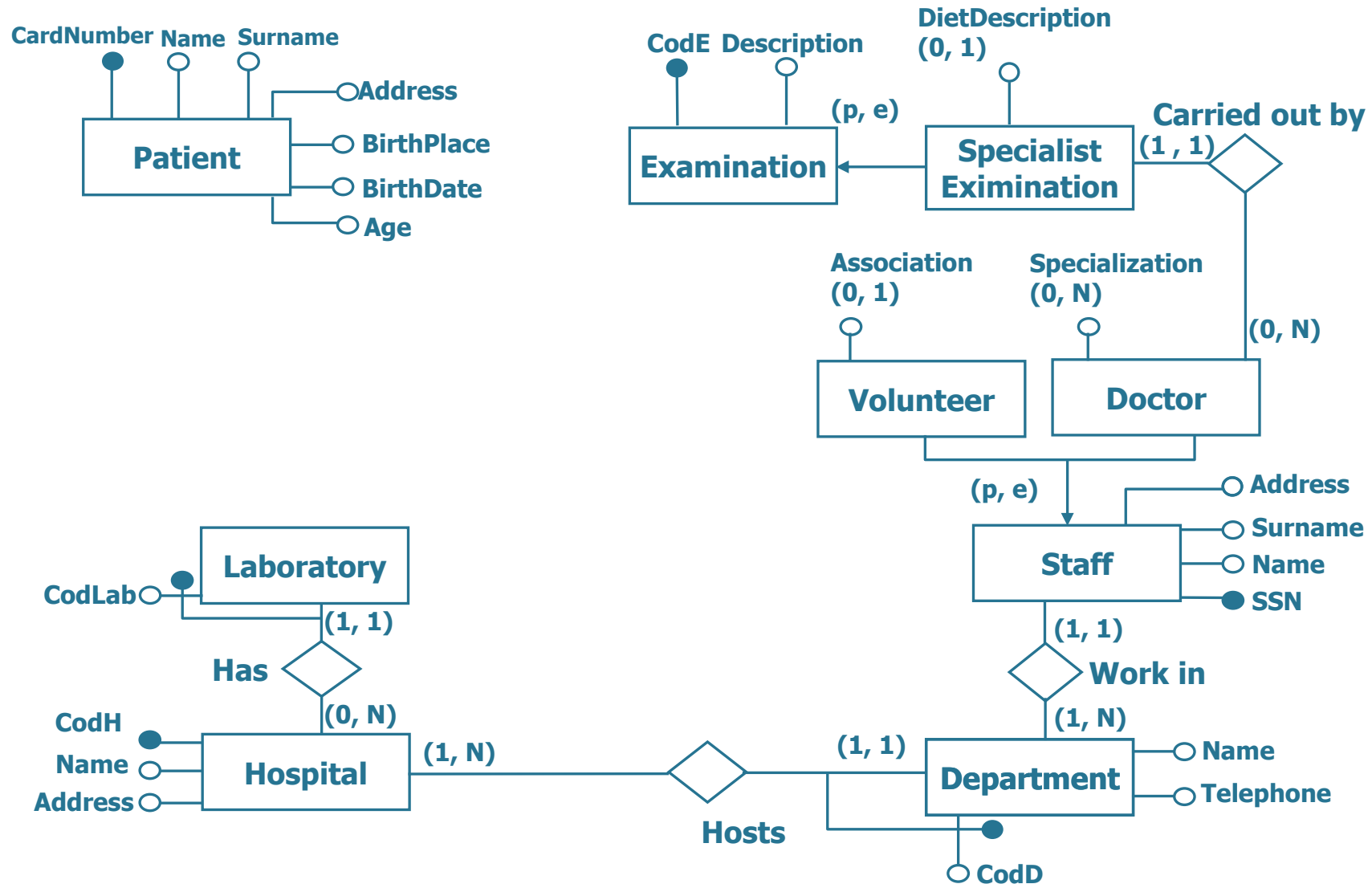


Relationship between Laboratory and Hospital

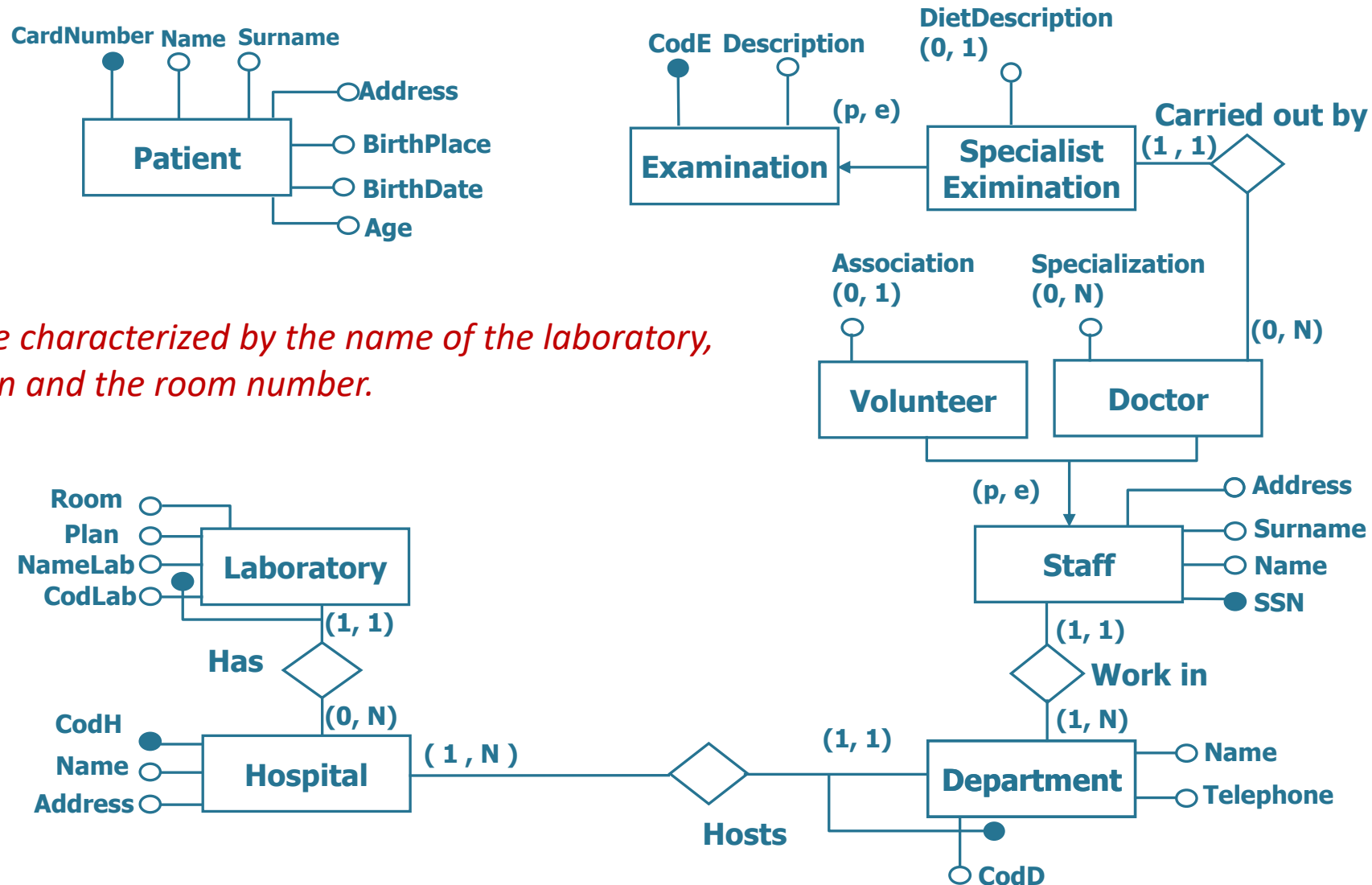


- The laboratories that perform the tests are identified by a unique code within the hospital and they are characterized by the name of the laboratory, the location plan and the room number.

Laboratory entity identifier



Refinement of the Laboratory entity



Laboratories are characterized by the name of the laboratory, the location plan and the room number.

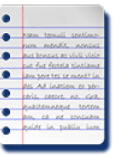
Database design

Representation of time (I)

Time representation

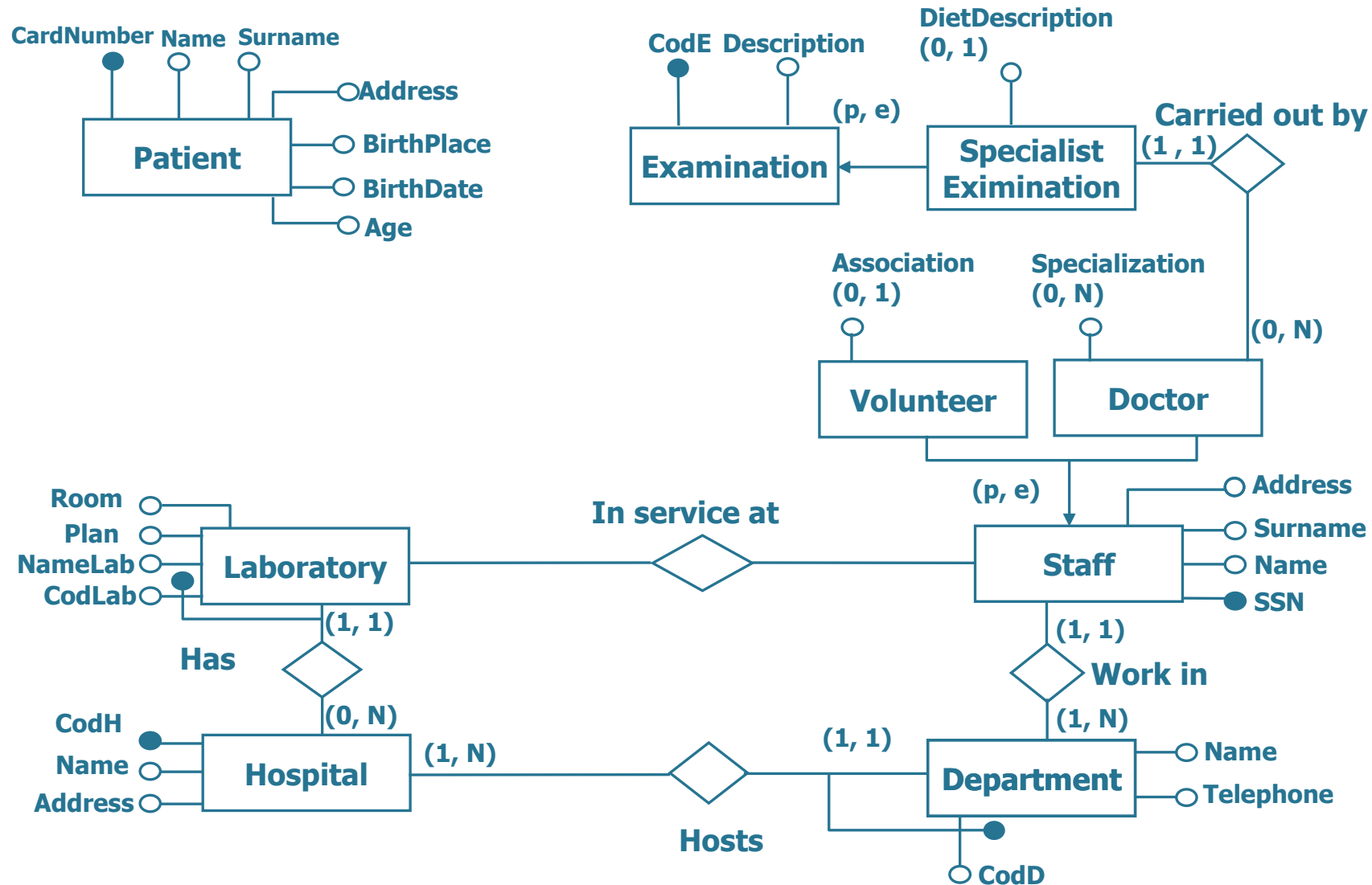
- It is necessary to explicitly represent time-related information in the case of
 - representation of events
 - changes in the information content of entities or time attributes
- Various patterns are possible
 - by means of N-ary relationship with a time entity
 - through historicized entities
 - through binary relationships with a time entity

Relationship between Staff and Laboratory

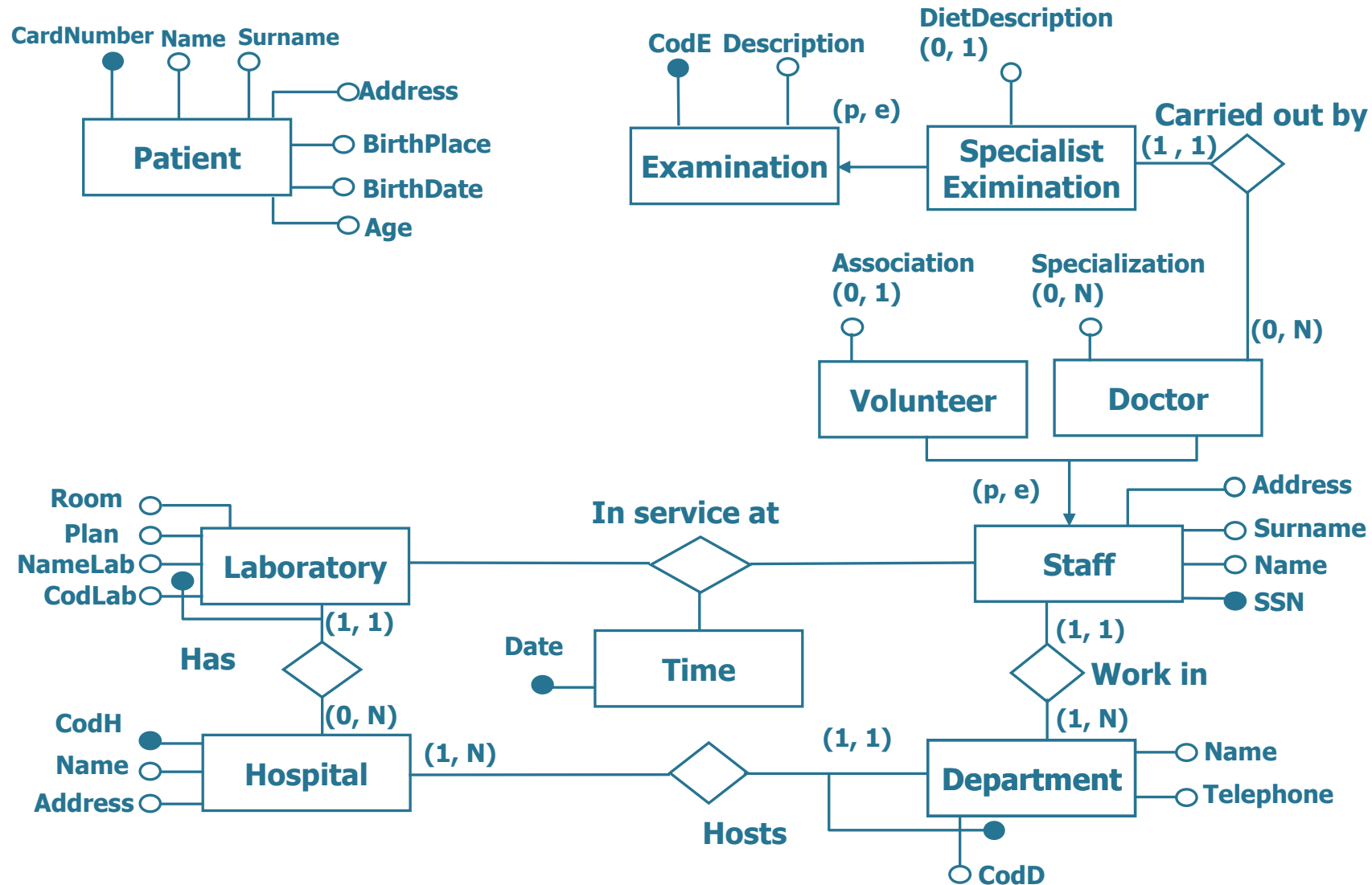


- For each member of the laboratory staff, the days and laboratories in which he/she works are stored. It should be borne in mind that during the same day each member of the staff can work in several laboratories.

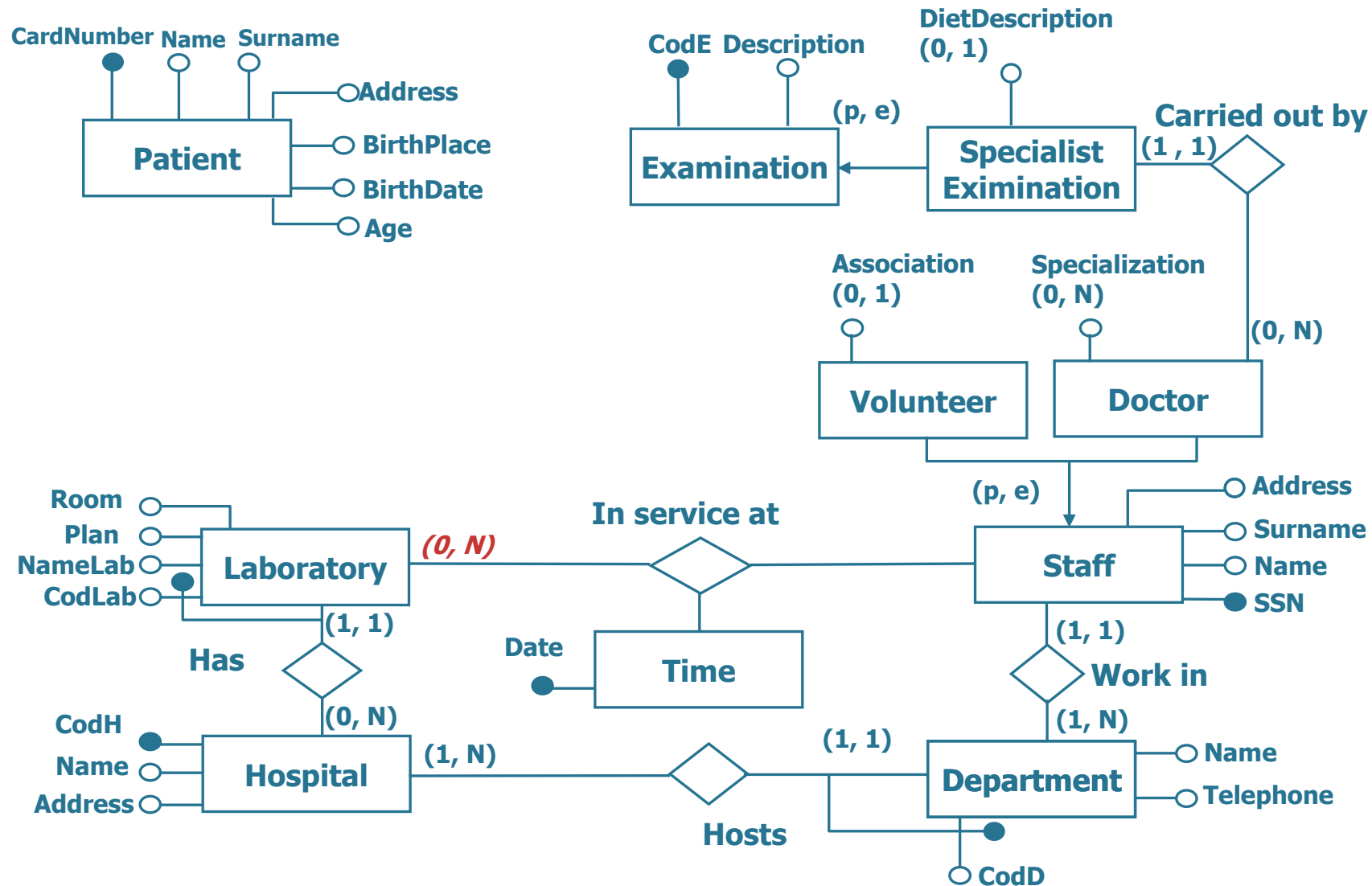
Relationship between Staff and Laboratory



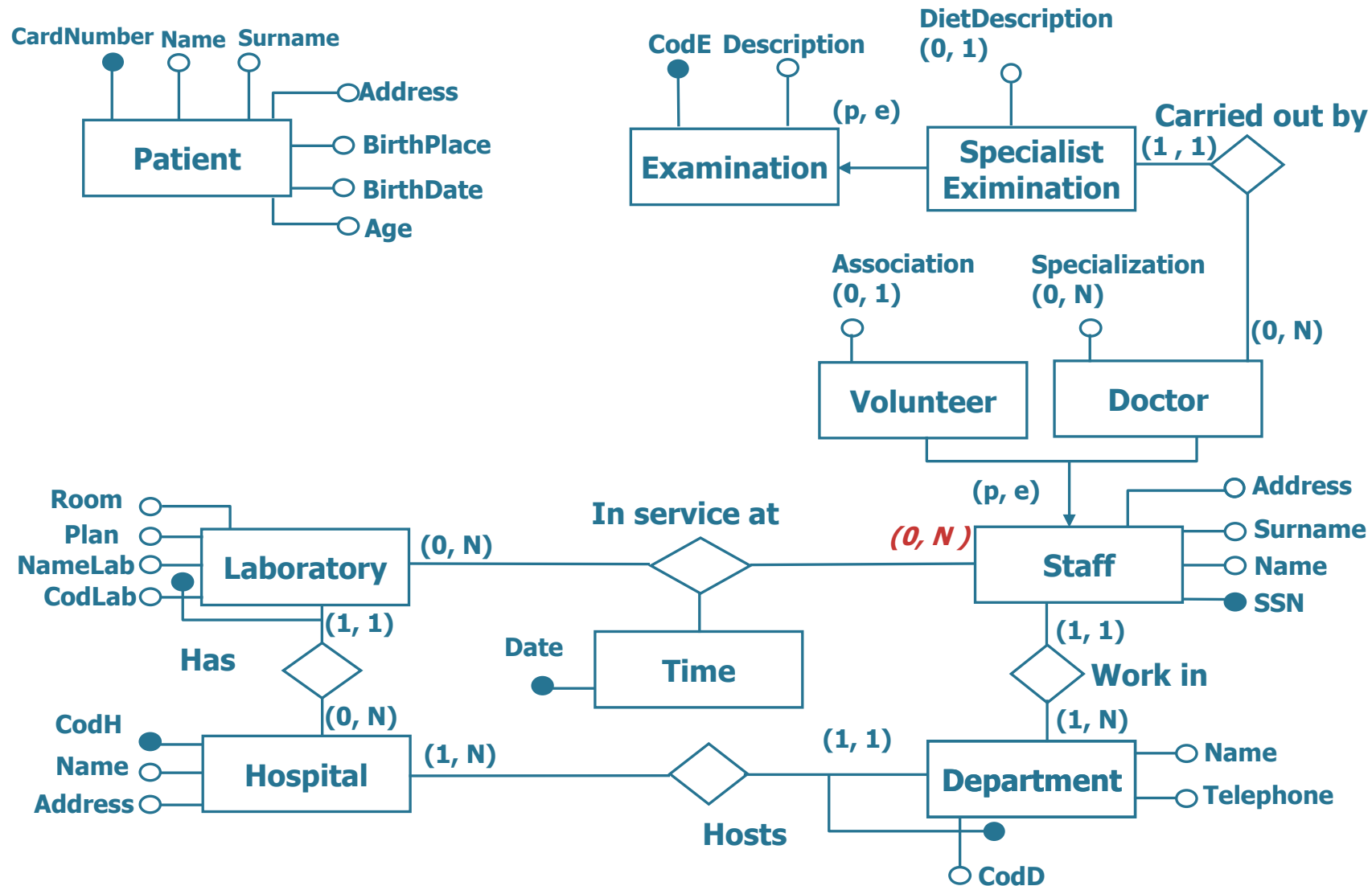
Relationship between Staff and Laboratory



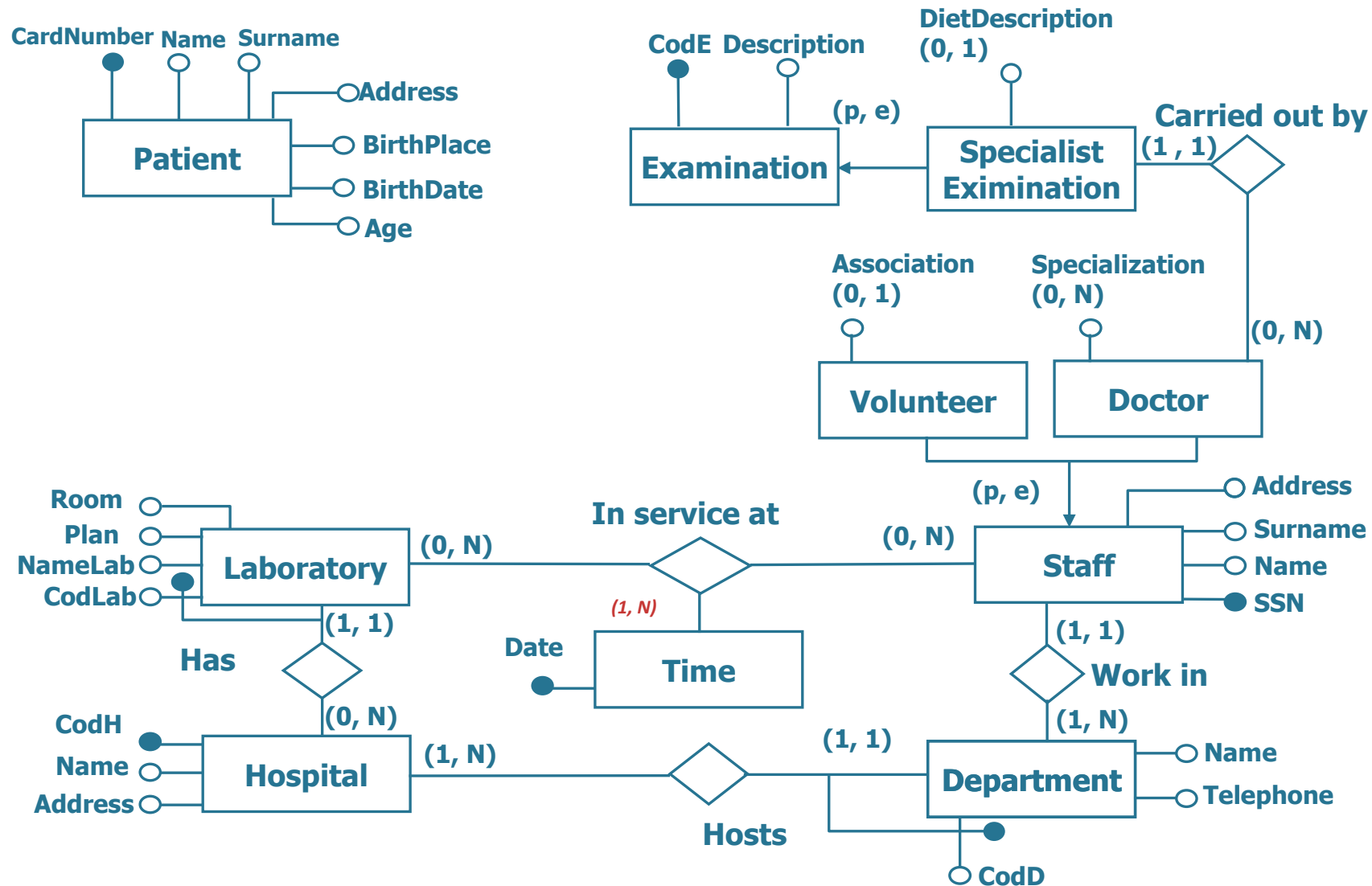
Cardinality of the *In service at* relationship



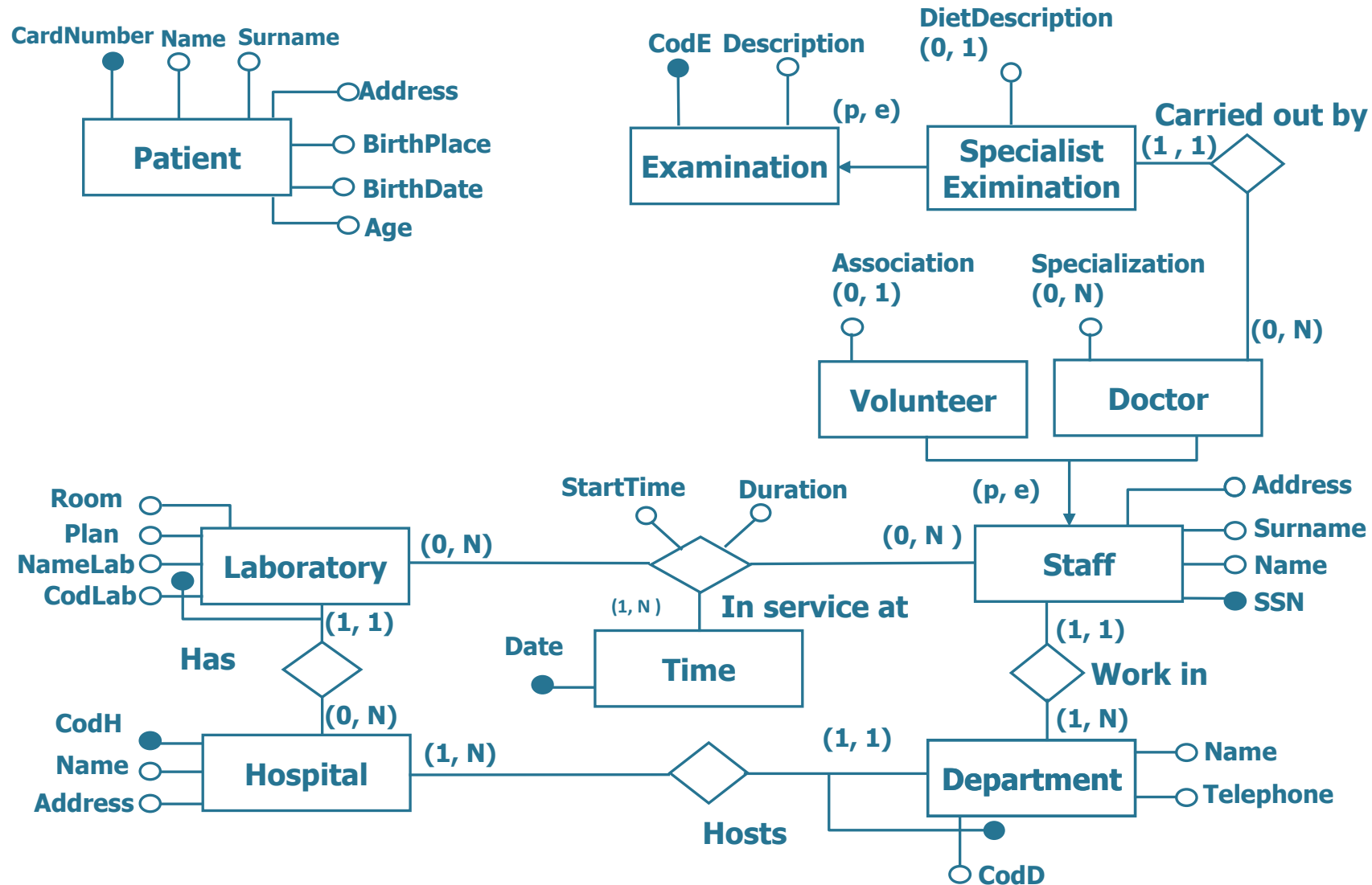
Cardinality of the *In service at* relationship

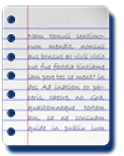


Cardinality of the *In service at* relationship



Cardinality of the *In service at* relationship

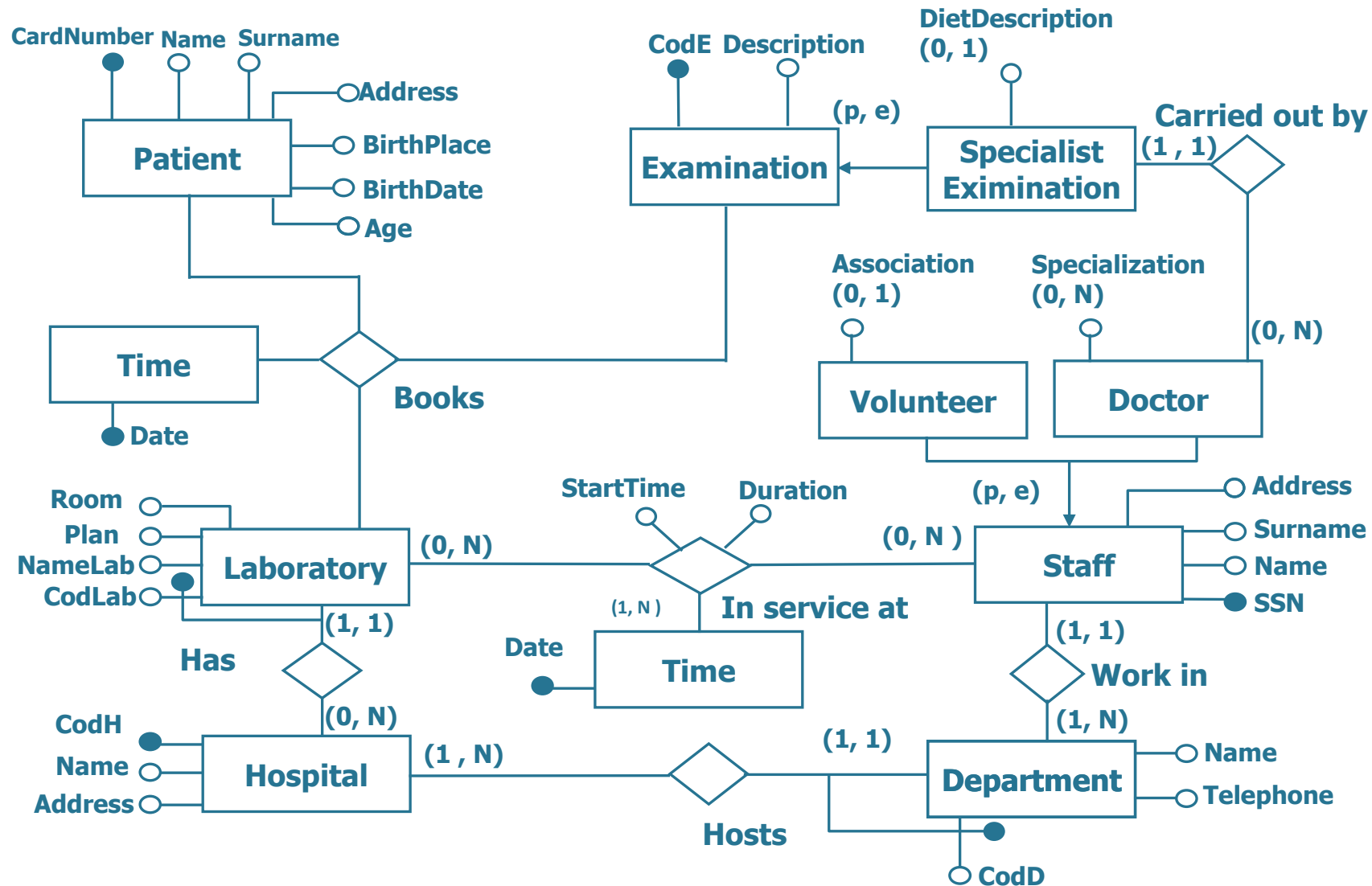




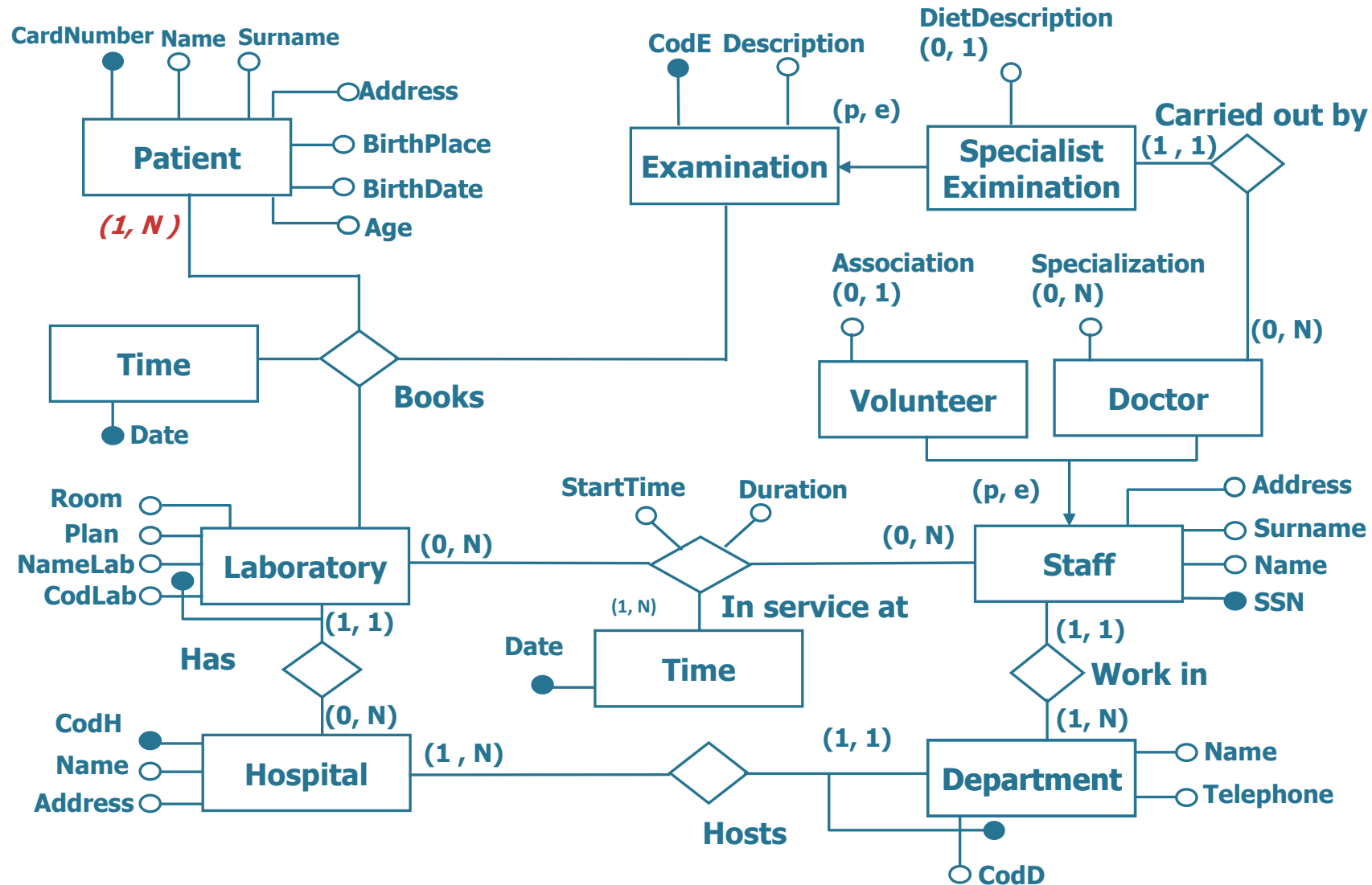
Representation of the reservation

- Each exam requires a reservation.
- For each exam reservation made by a patient, the date and time of the exam, the laboratory where it is performed, the cost of the ticket and the information about the exam being urgent or not are stored.
- Please note that each patient can make multiple reservations for the same exam on different dates and the same exam cannot be repeated on the same day by the same patient, even in different laboratories.

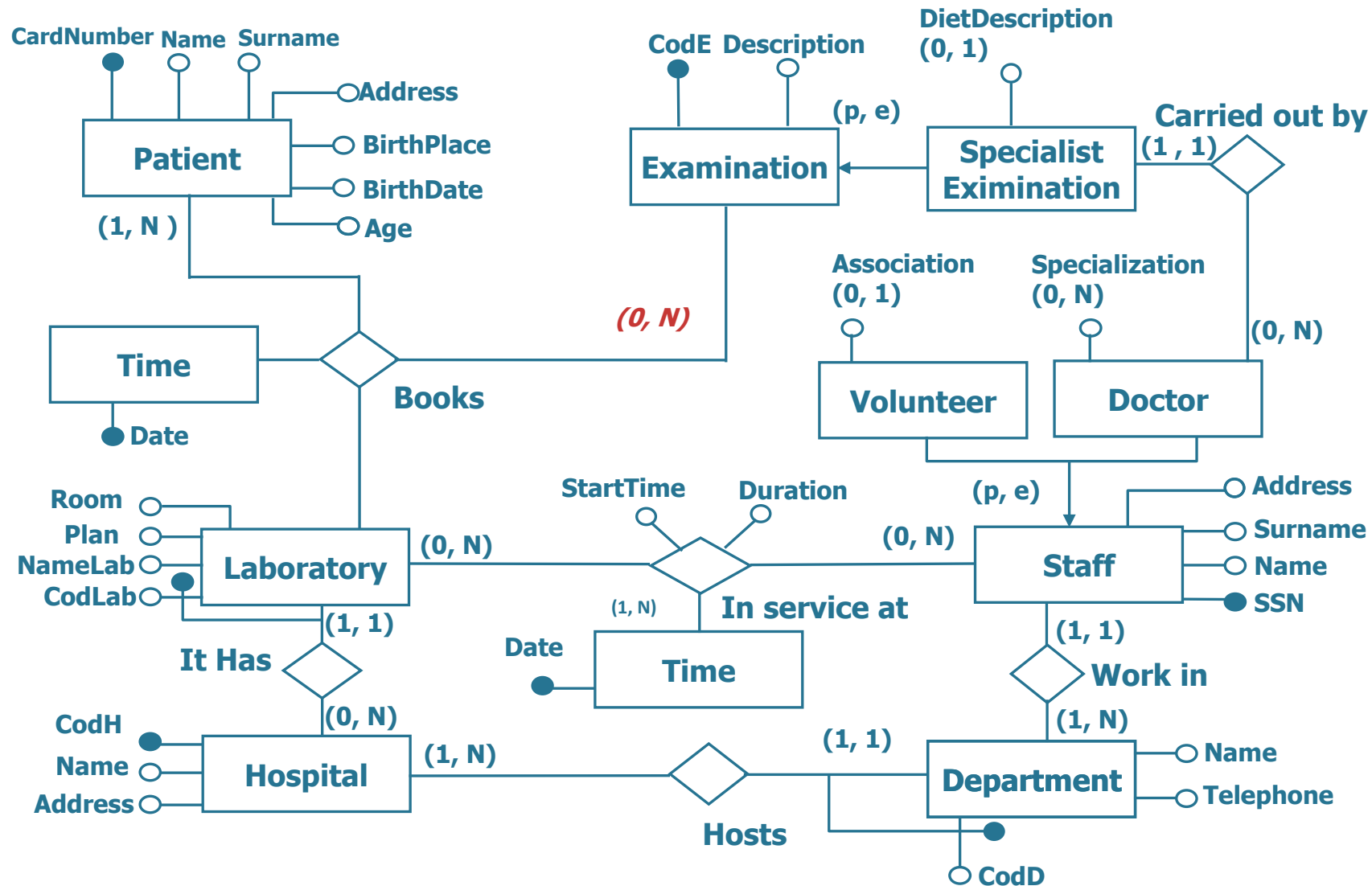
Representation of the reservation



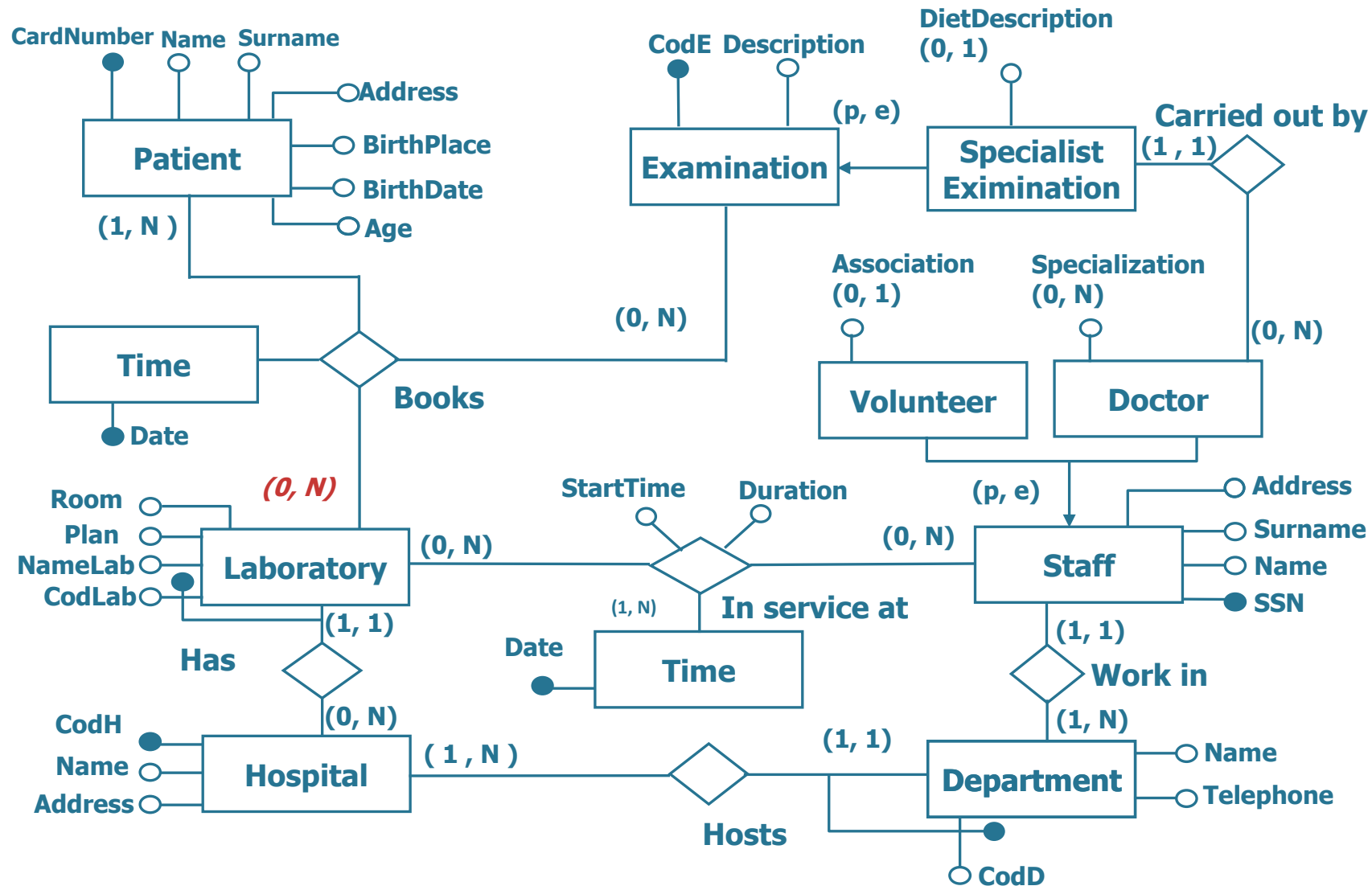
Cardinality of the *Books* relationship

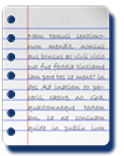


Cardinality of the *Books* relationship



Cardinality of the *Books* relationship

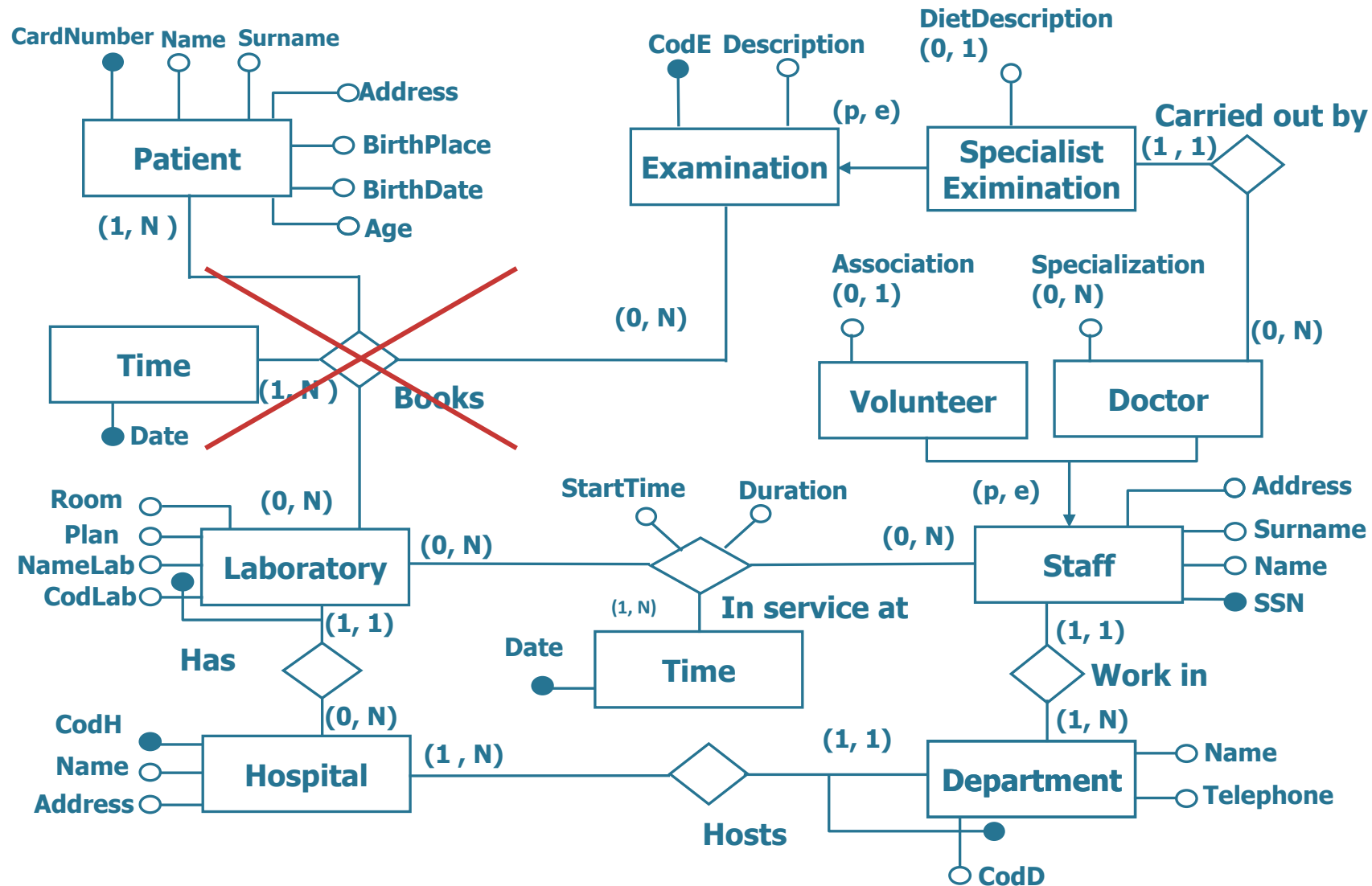




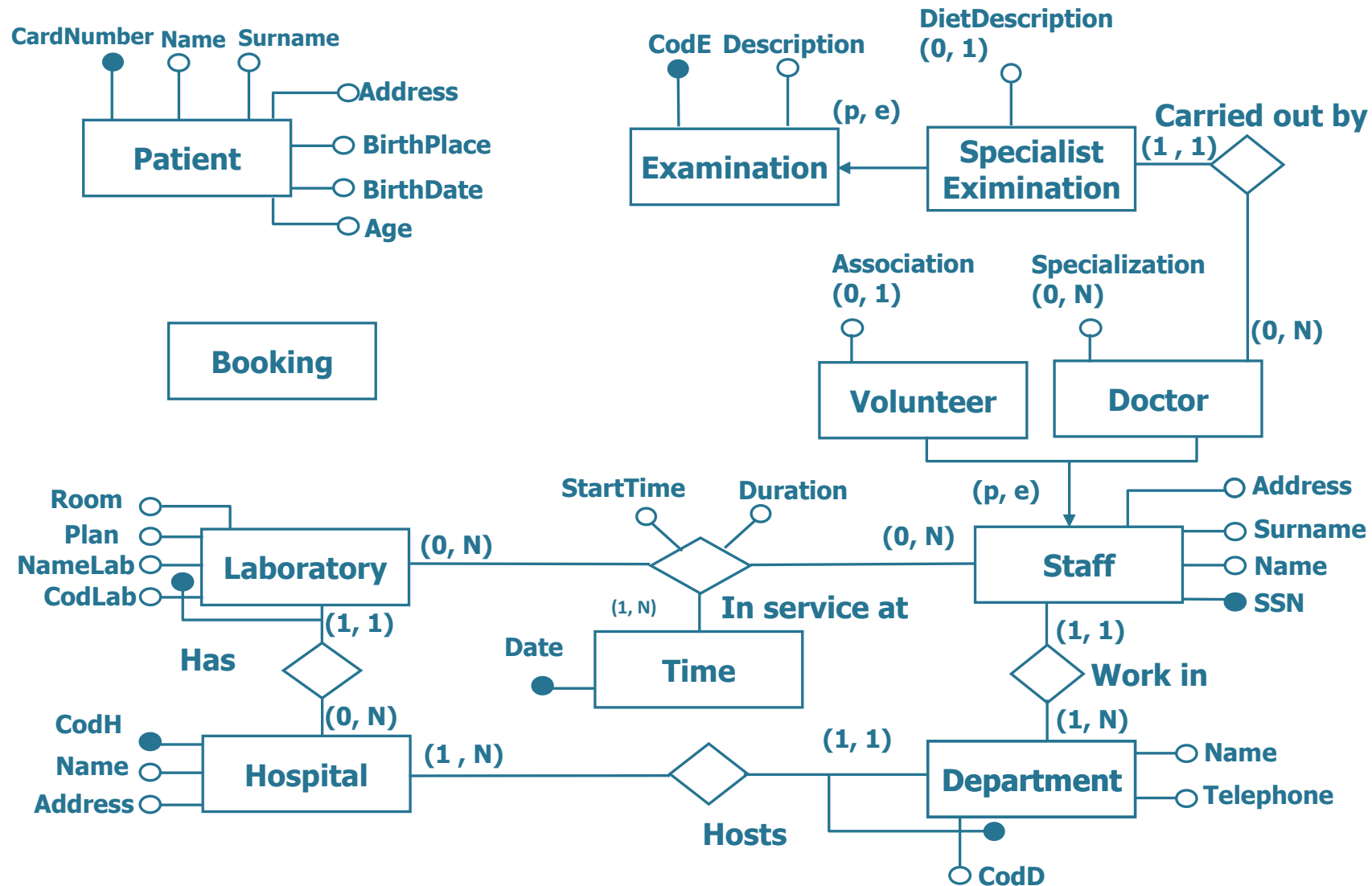
Reservation constraints

- Each exam requires a reservation.
- For each exam reservation made by a patient, the date and time of the exam, the laboratory where it is performed, the cost of the ticket and the information about the exam being urgent or not are stored.
- *Please note that each patient can make multiple reservations for the same exam on different dates and the same exam cannot be repeated on the same day by the same patient, even in different laboratories.*

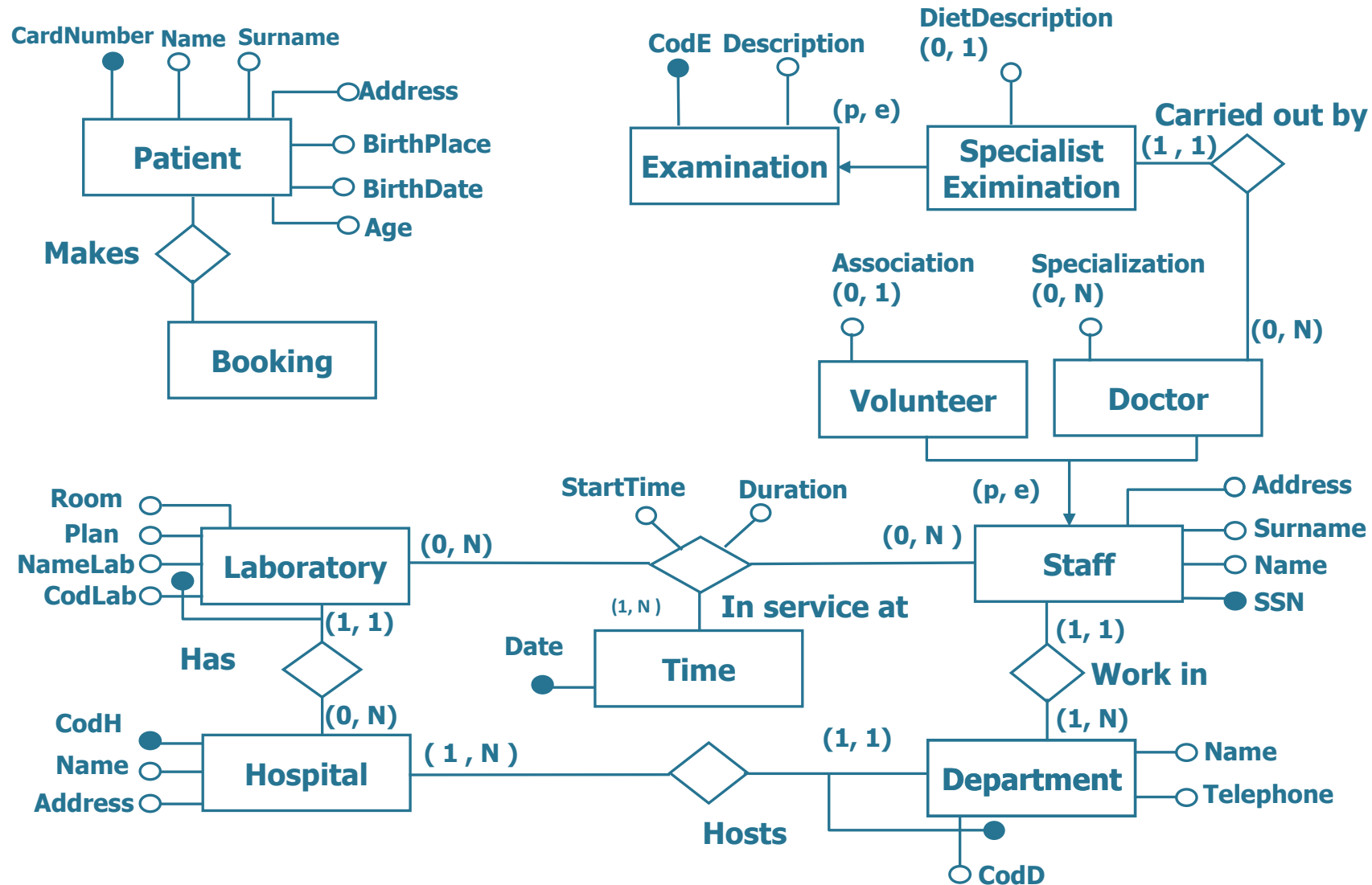
Representation of the reservation



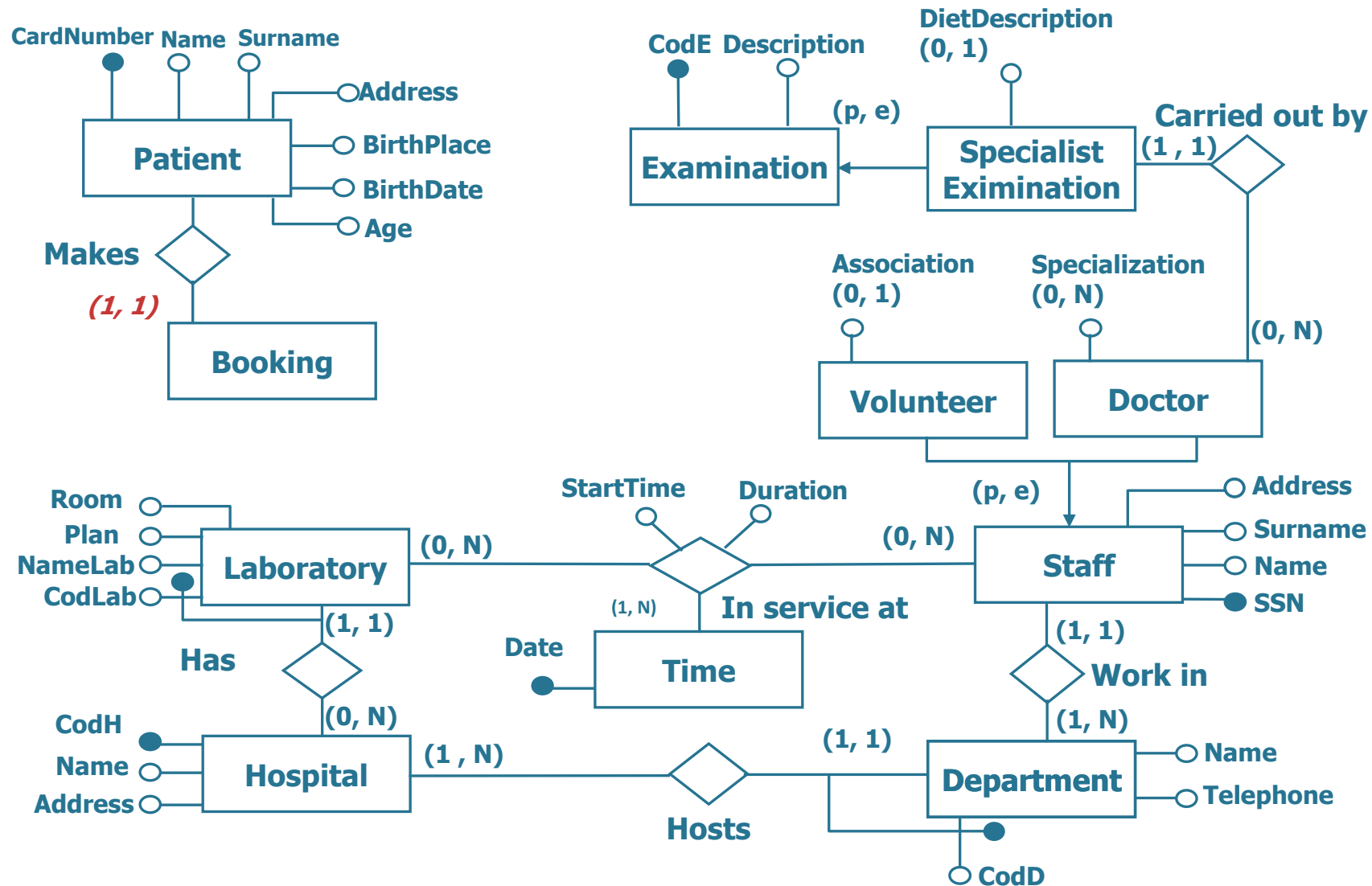
Introducing the Booking entity



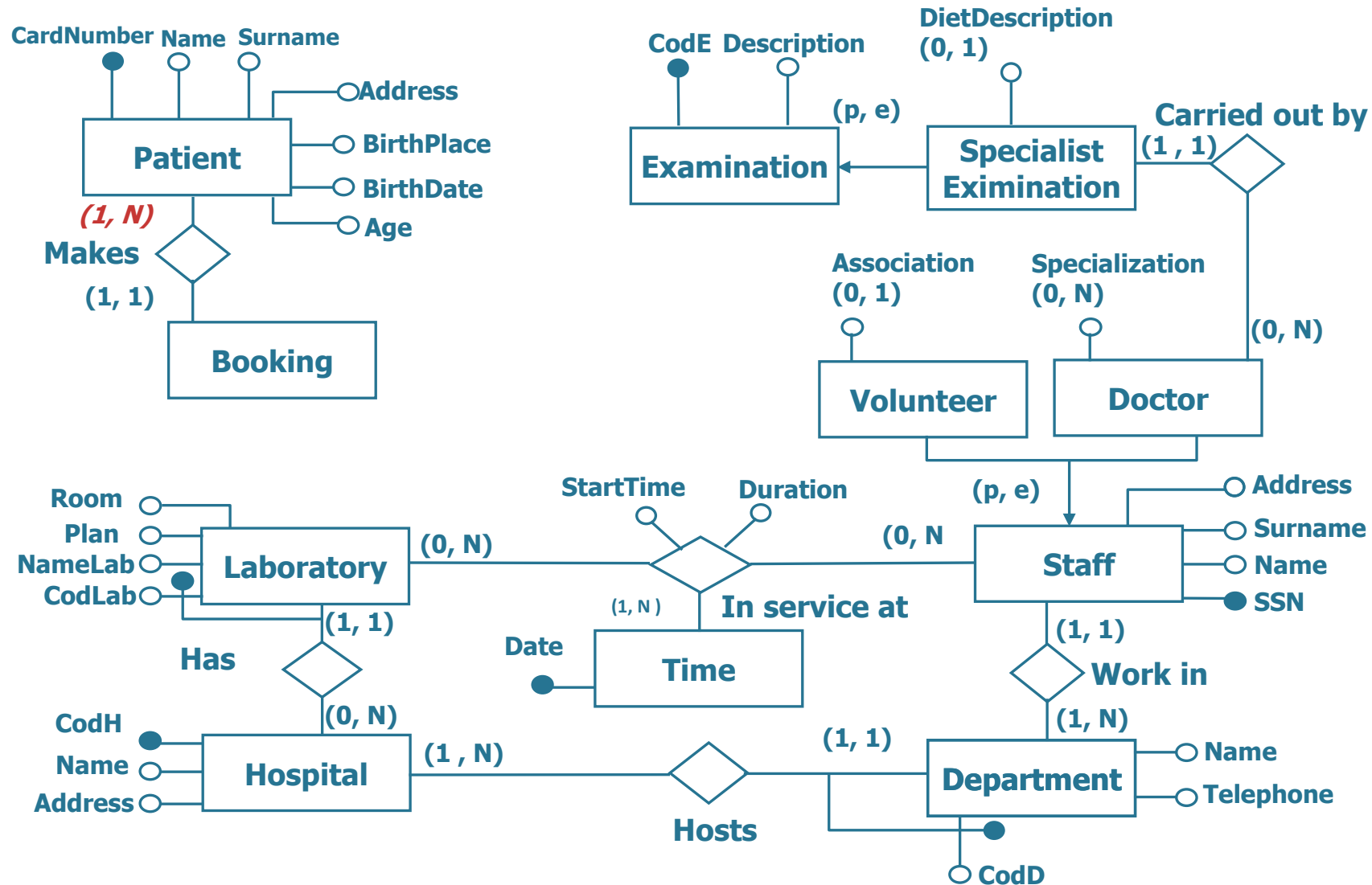
Relationship between Booking and Patient



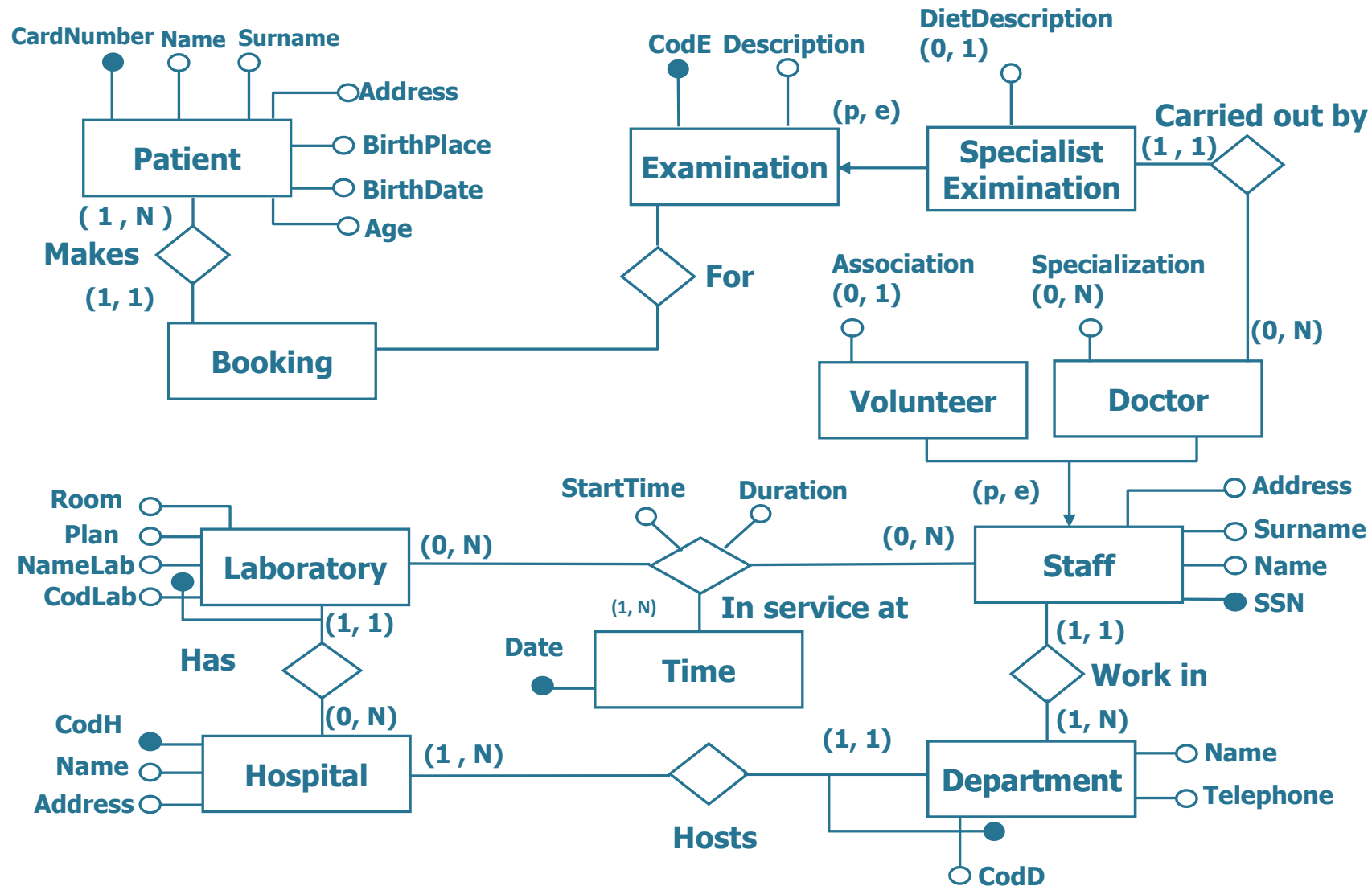
Cardinality of the *Makes* relationship



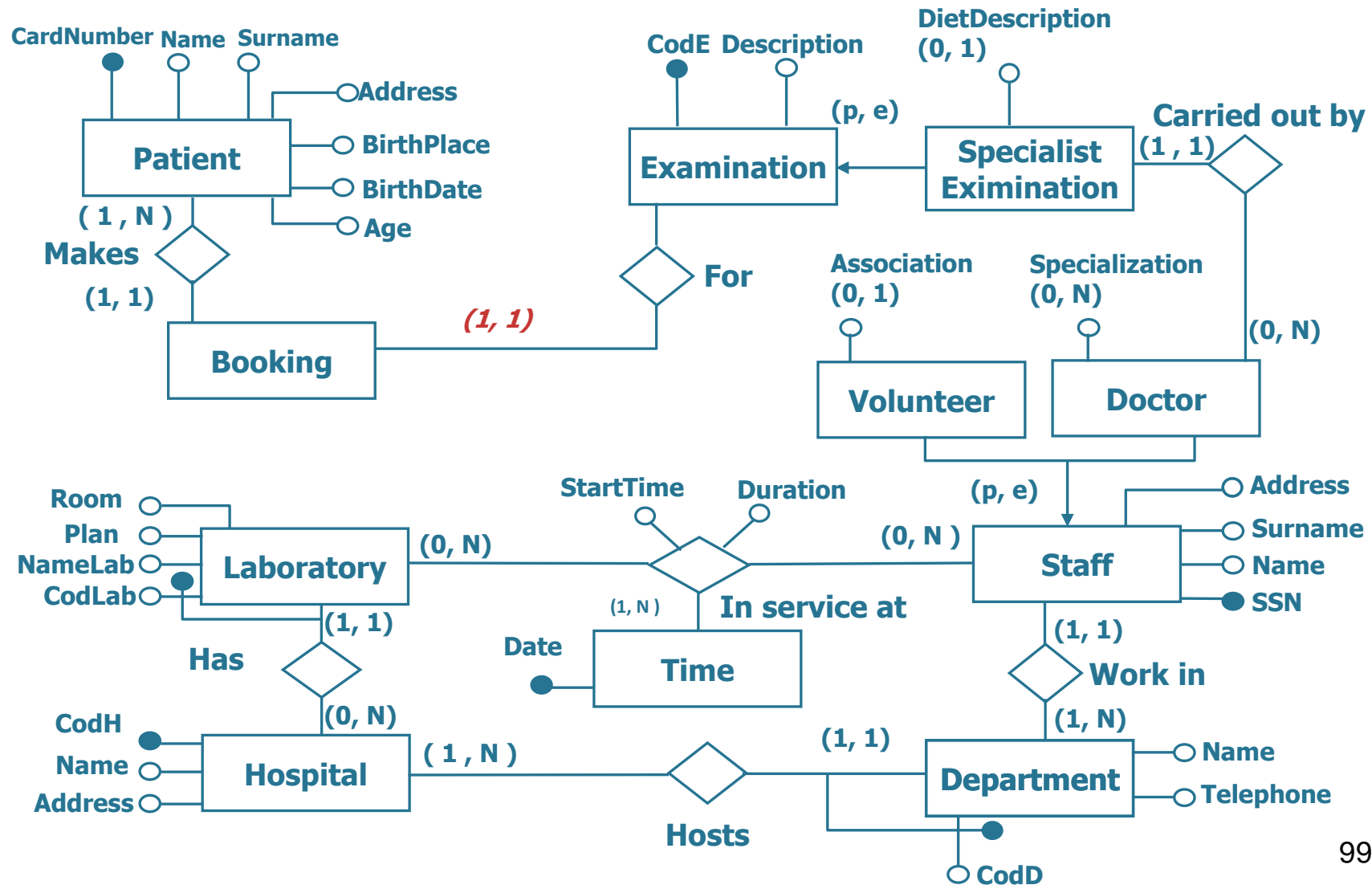
Cardinality of the *Makes* relationship



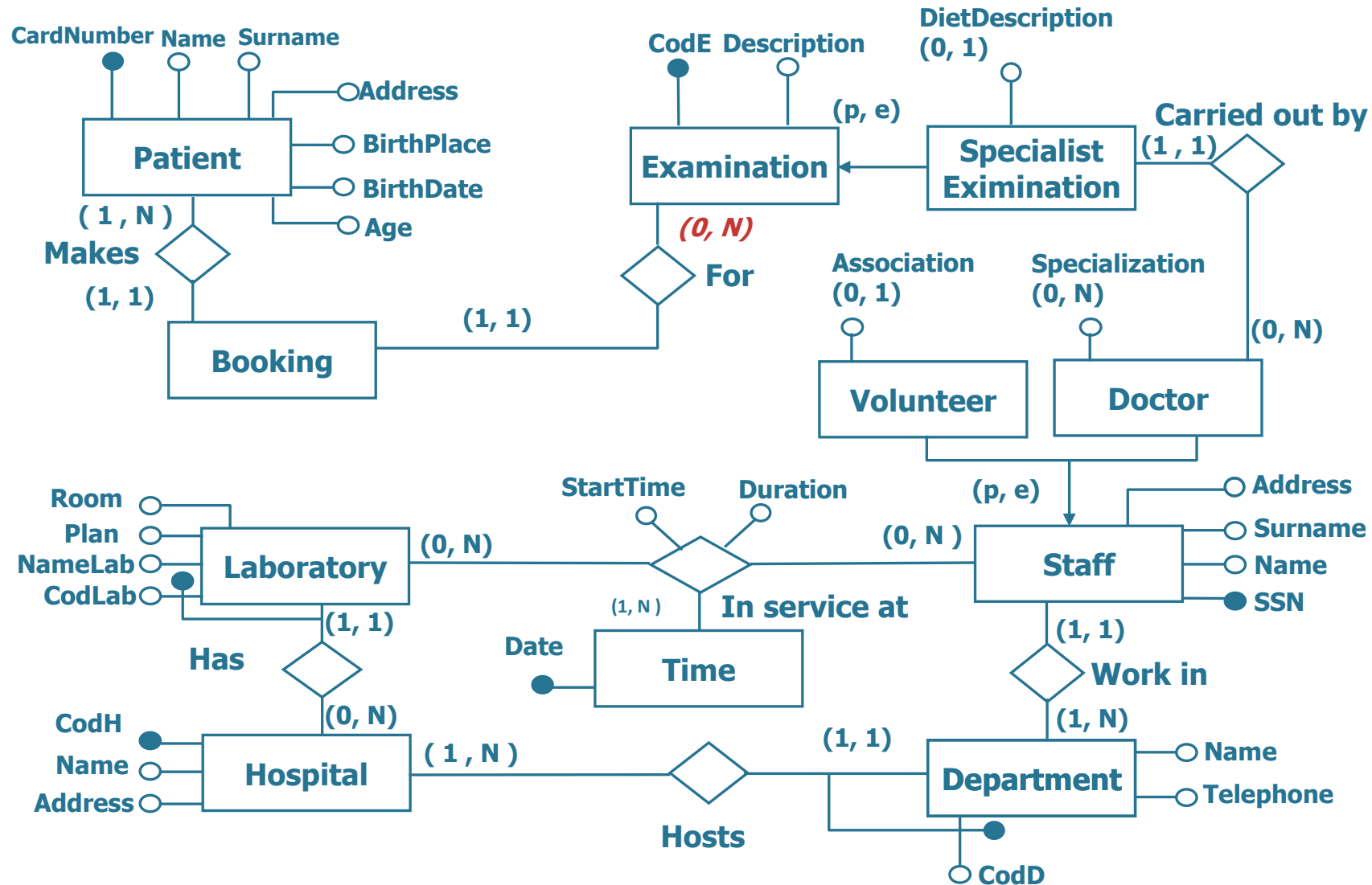
Relationship between Booking and Patient



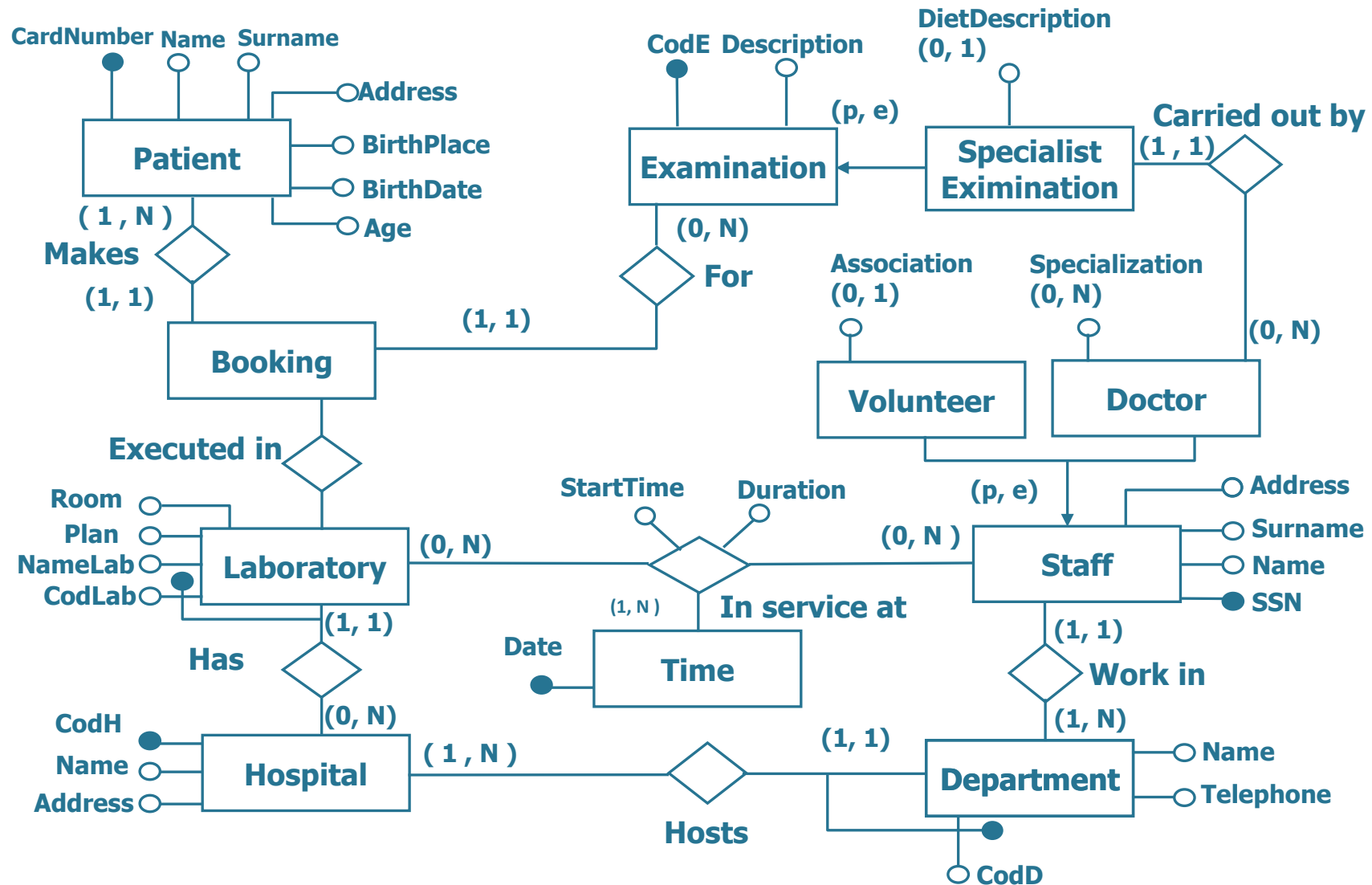
Cardinality of the *For* relationship



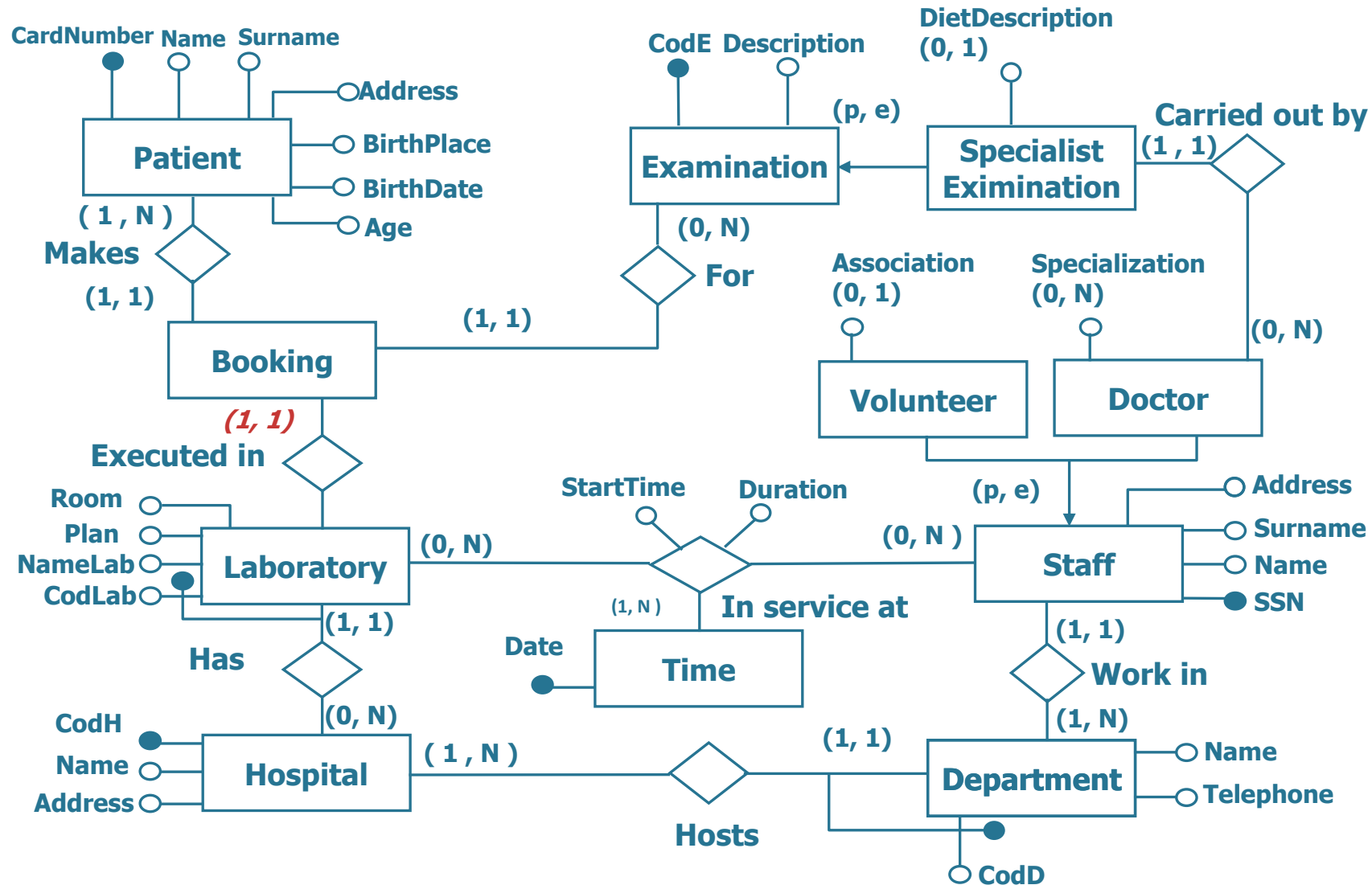
Cardinality of the *For* relationship



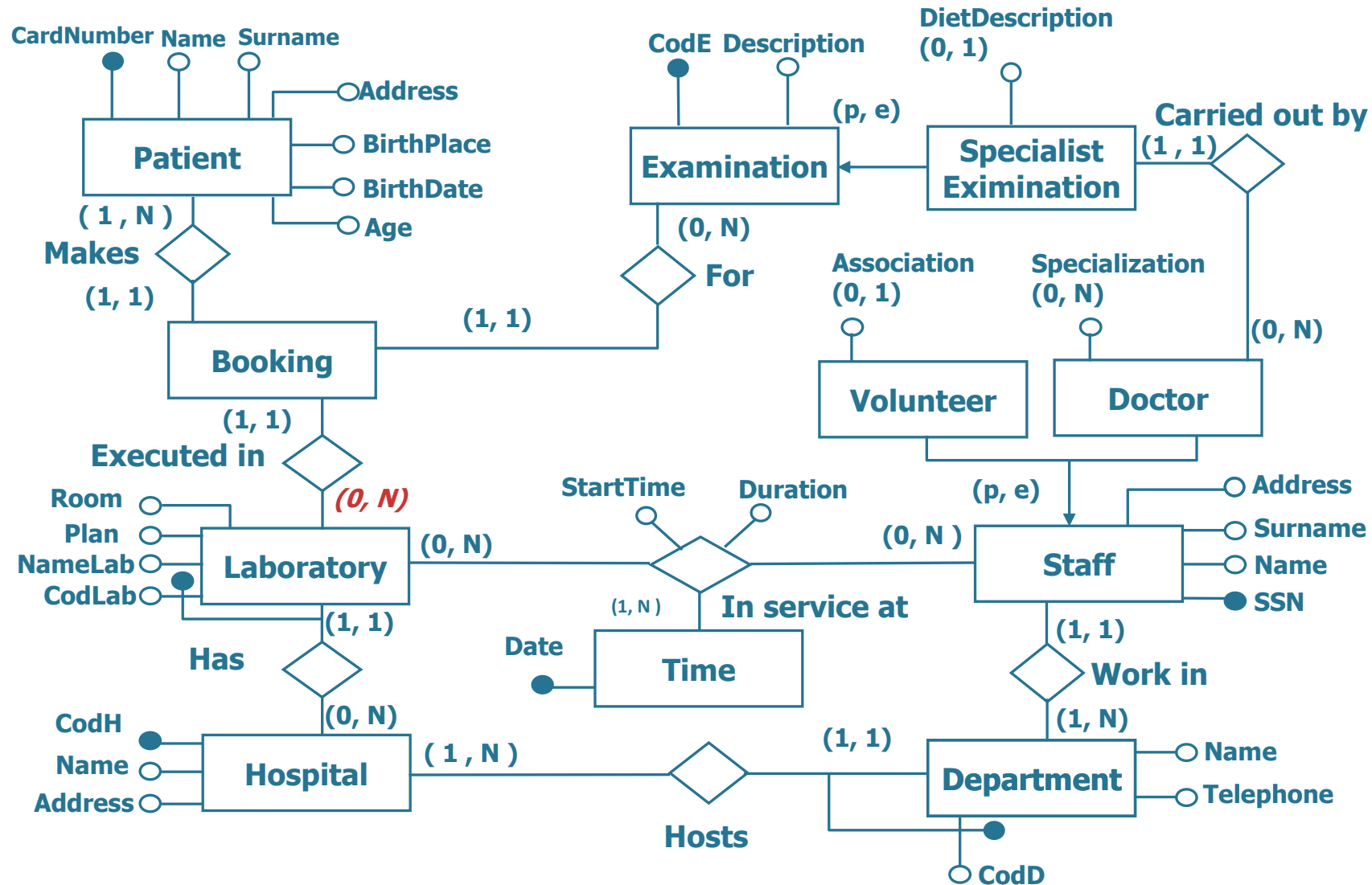
Relationship between Booking and Laboratory



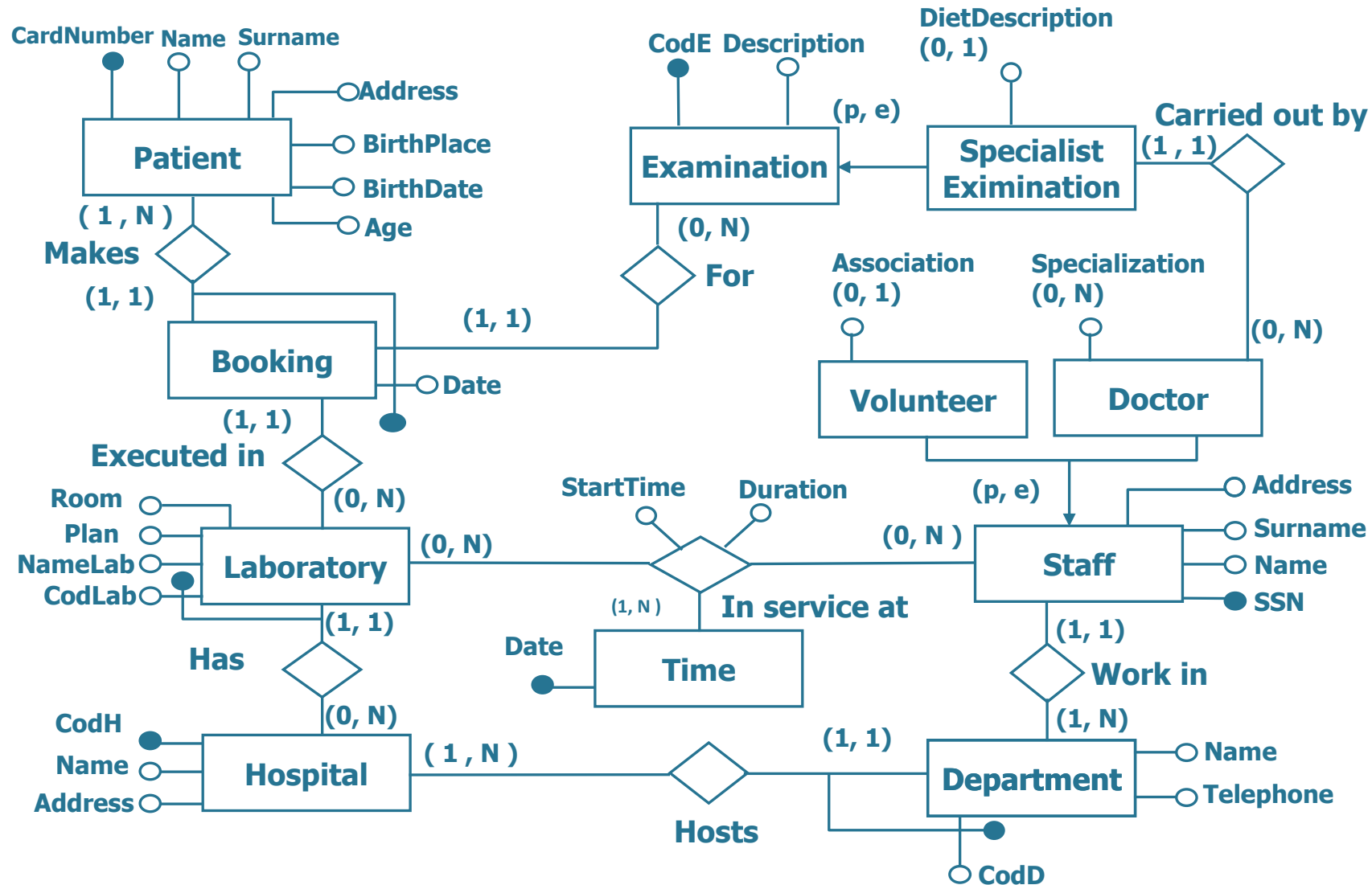
Cardinality of the *Executed in* relationship



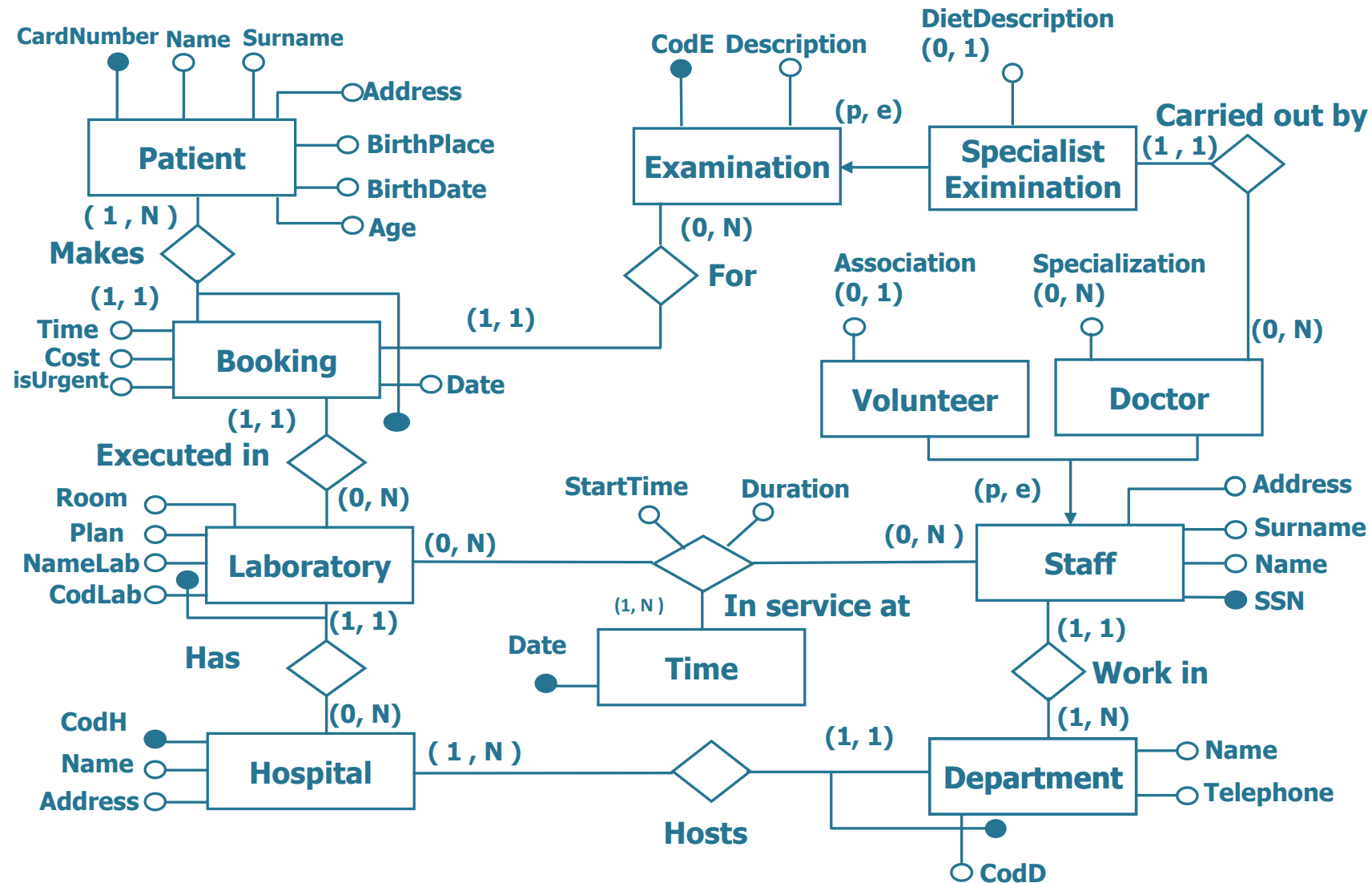
Cardinality of the *Executed in* relationship

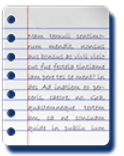


Booking entity identifier



Refinement of the Booking entity

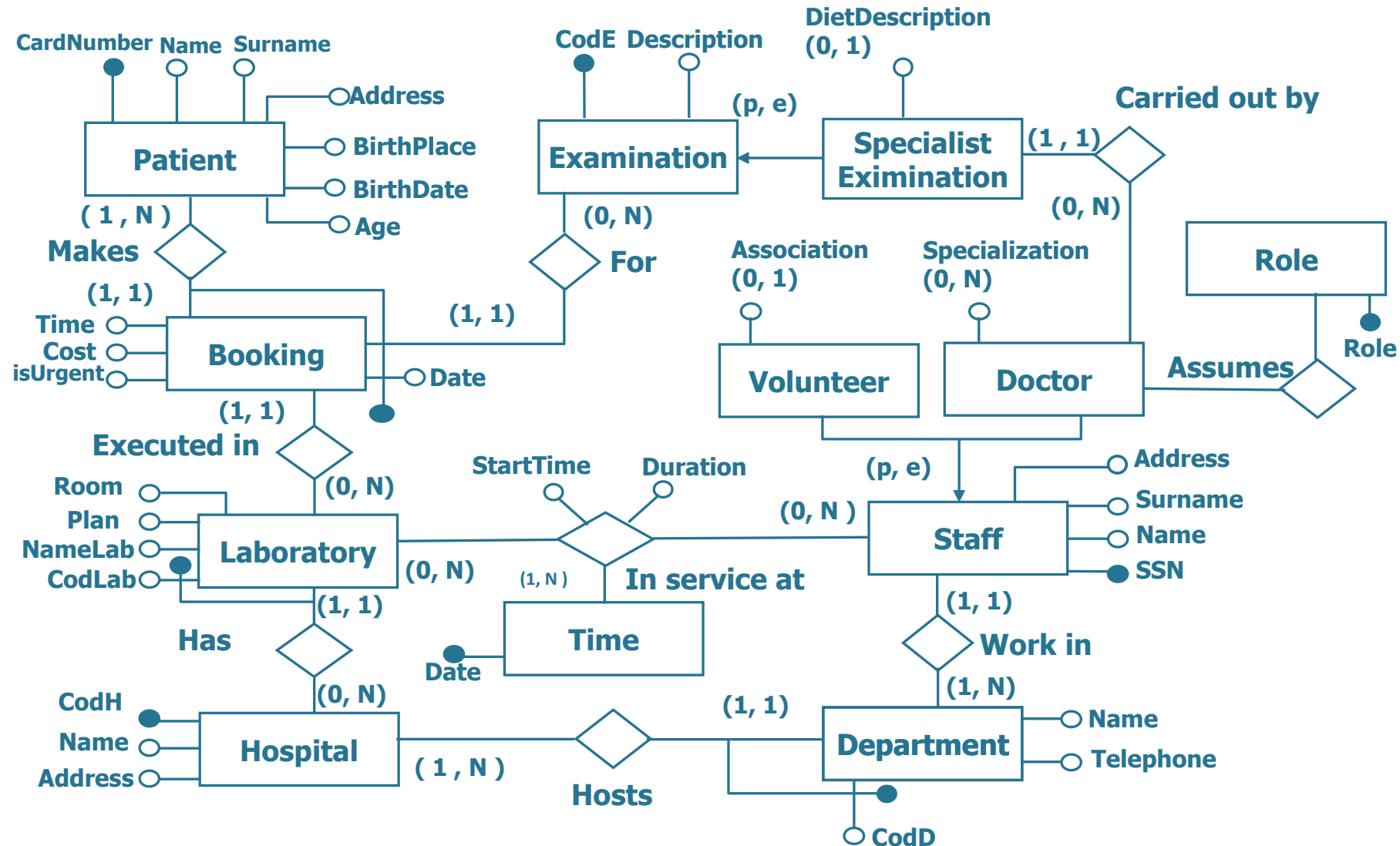




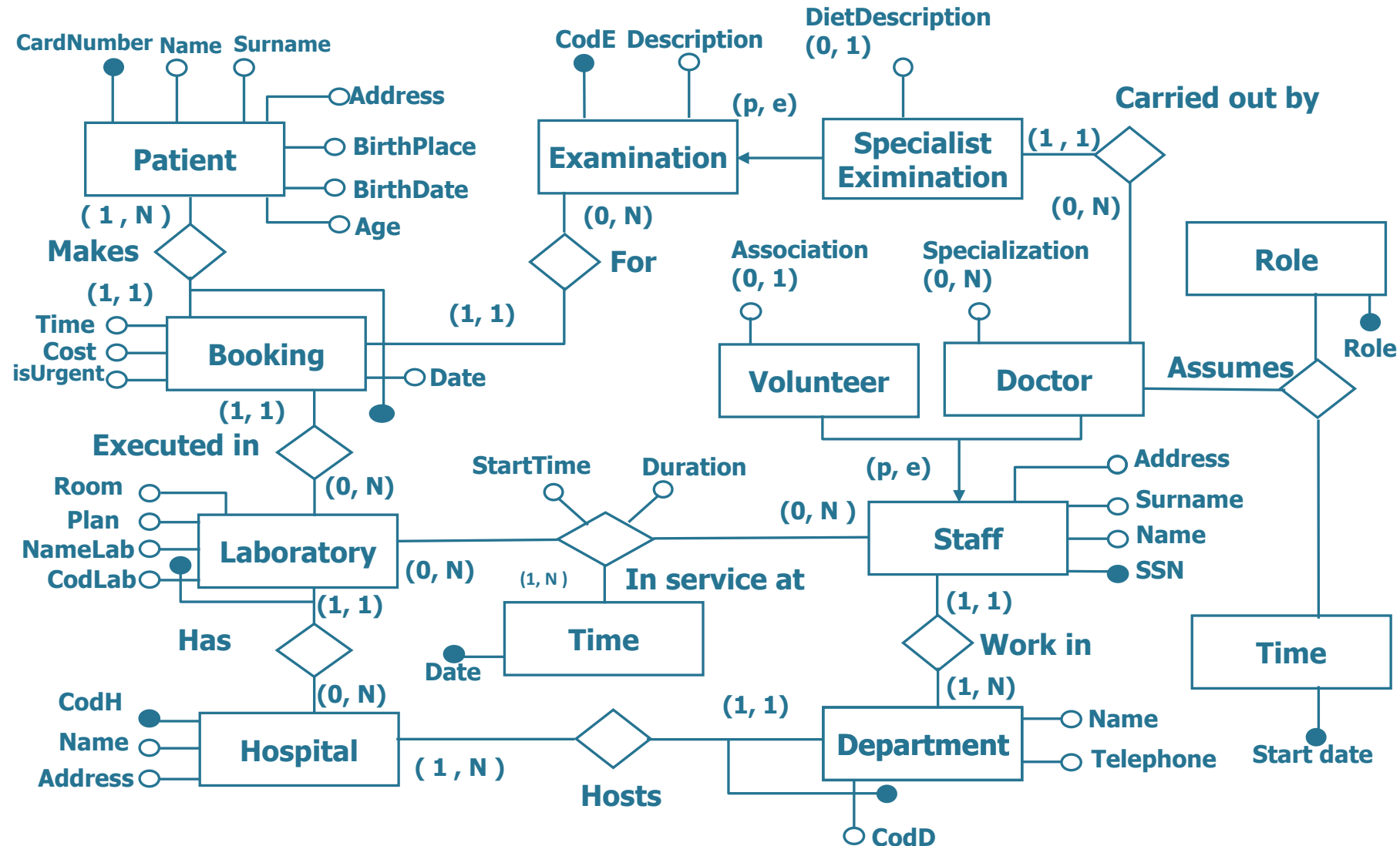
Relationship between Doctor and Role

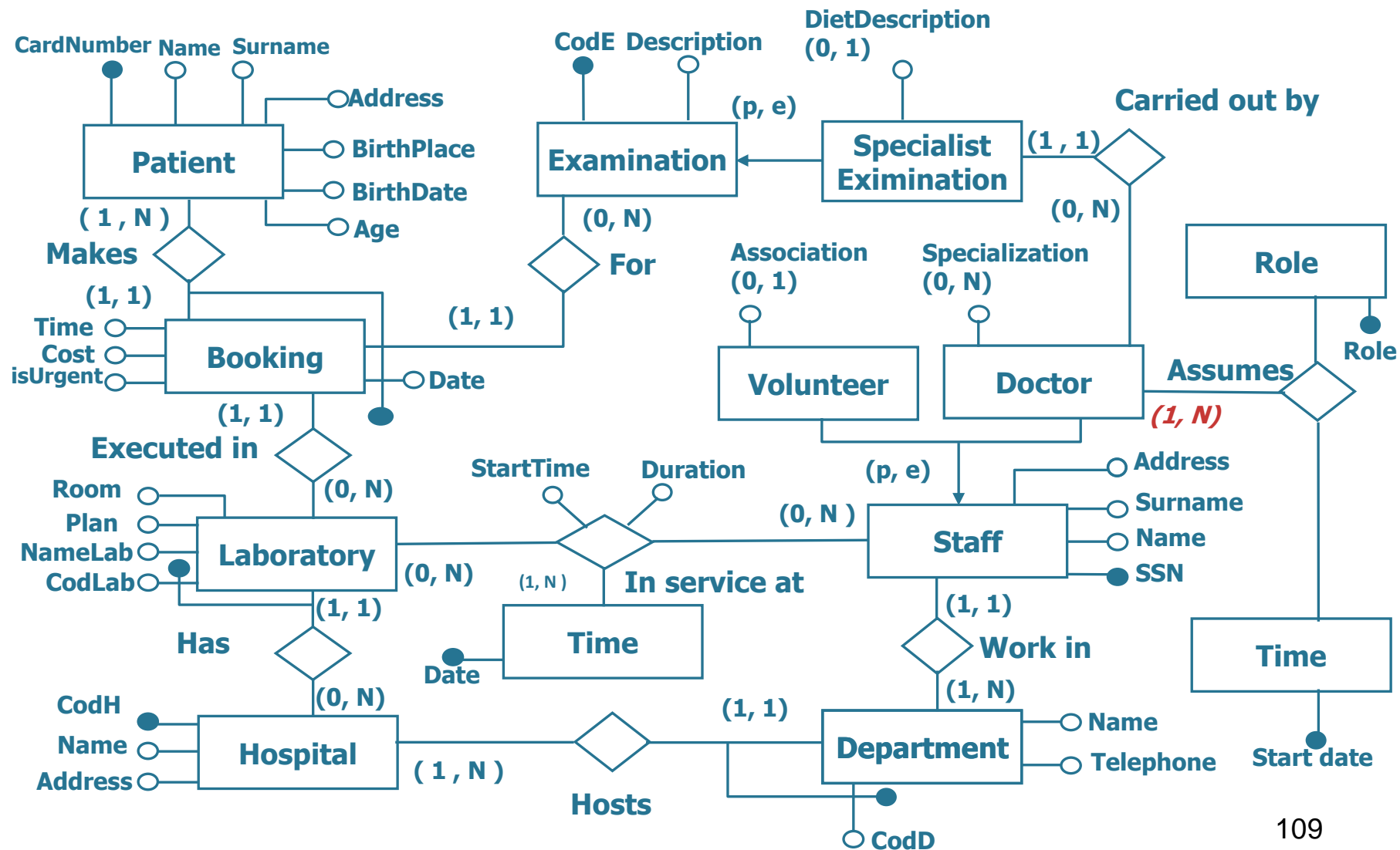
- Each doctor can take on different roles during his/her career (e.g. assistant, head physician, etc.).
We want to keep track of the roles each doctor has taken on during his/her career and the related time periods (start date, end date).
Keep in mind that each doctor cannot take on more than one role at the same time, but he/she can take on the same role in different time periods.

Relationship between Doctor and Role

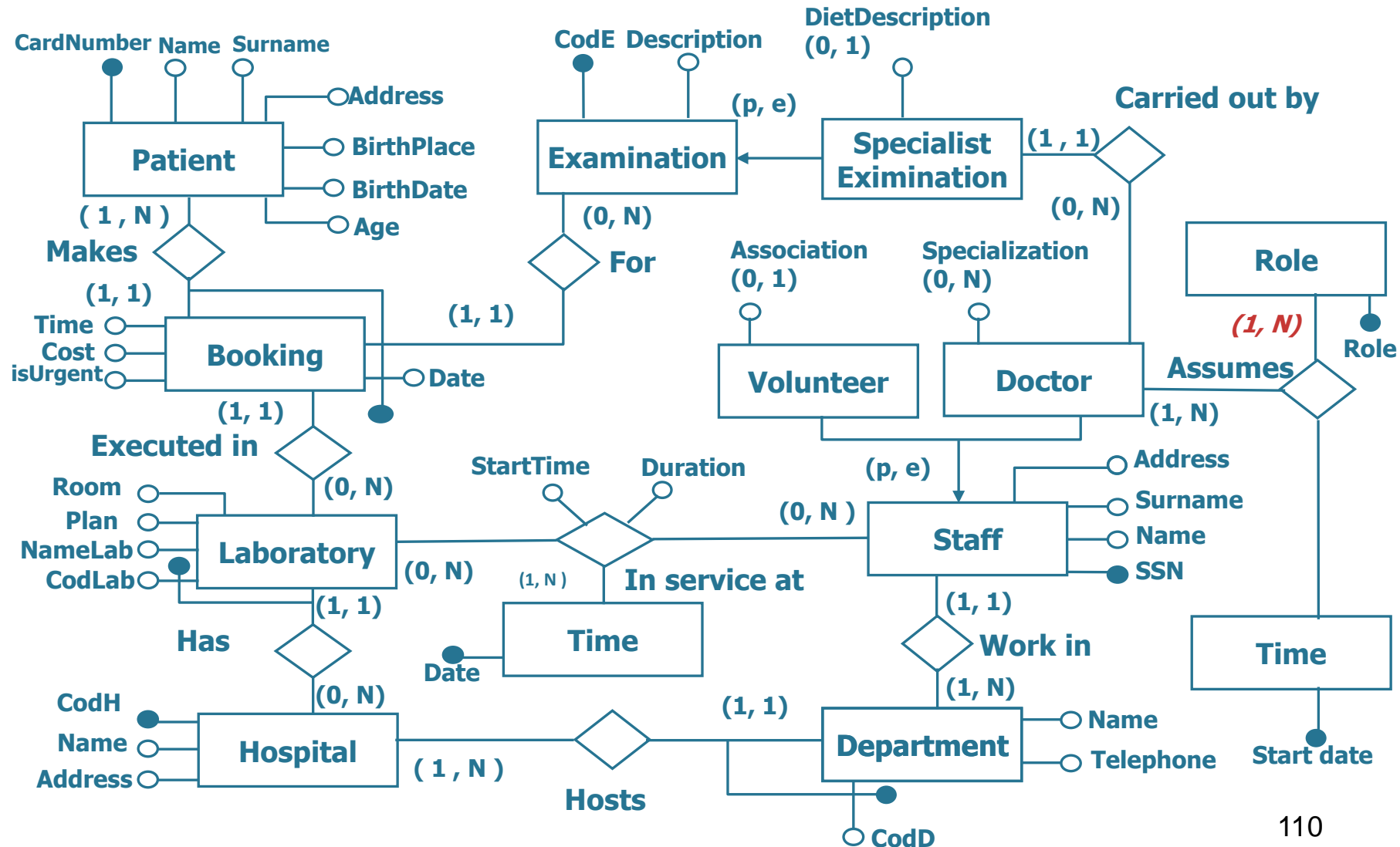


Relationship between Doctor and Role

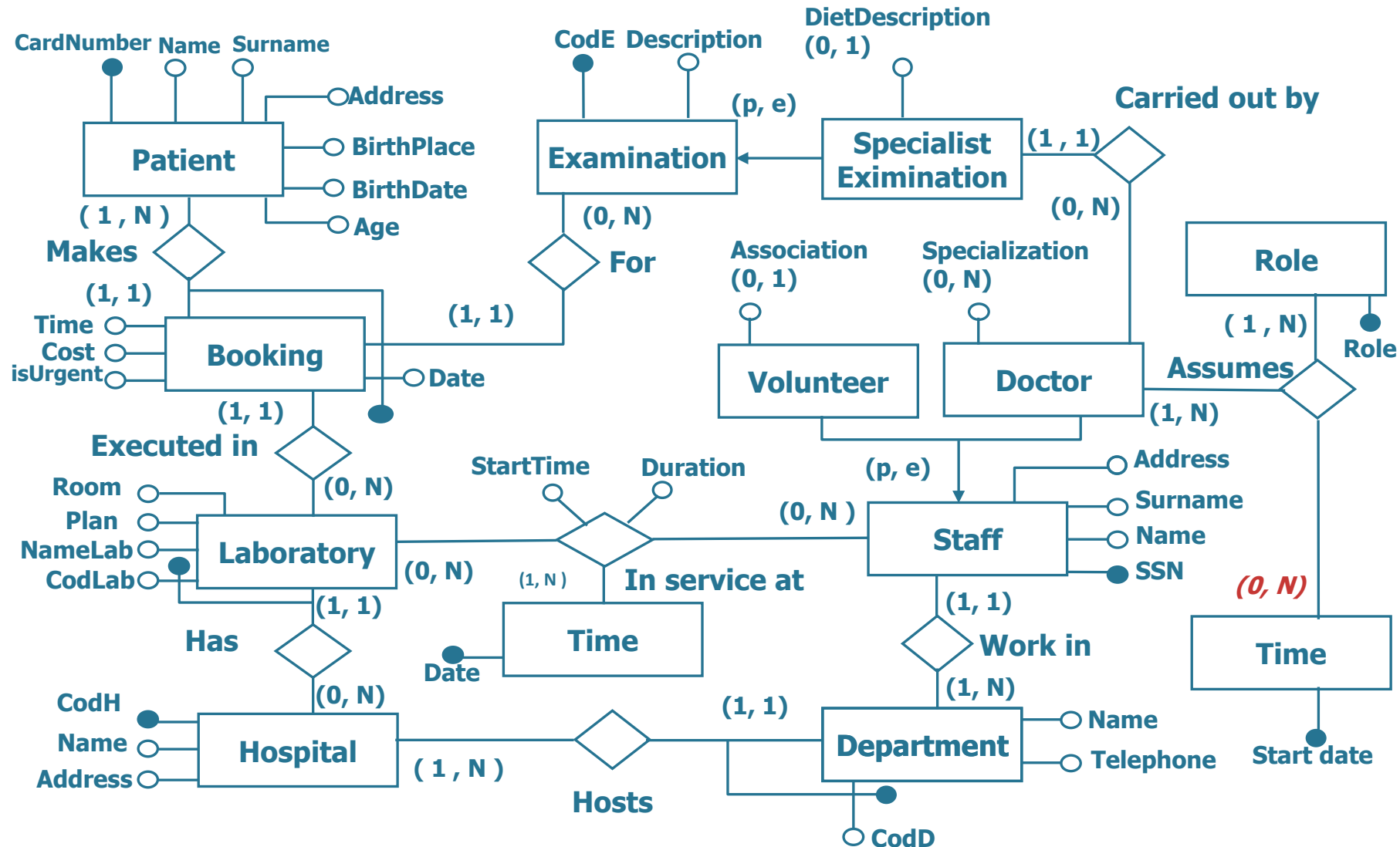




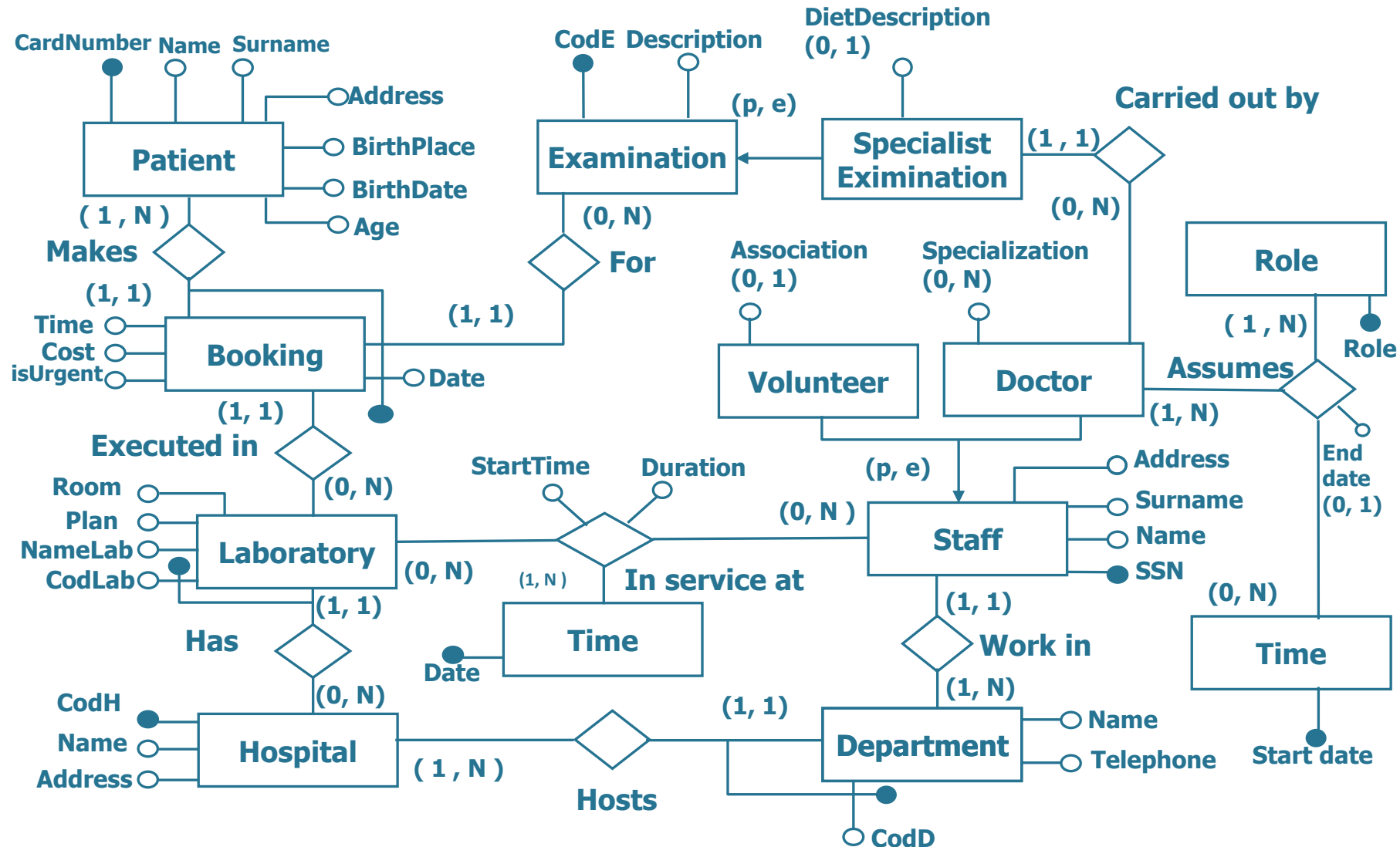
Cardinality of the *Assumes* relationship

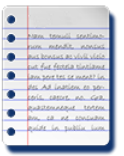


Cardinality of the *Assumes* relationship



Cardinality of the *Assumes* relationship





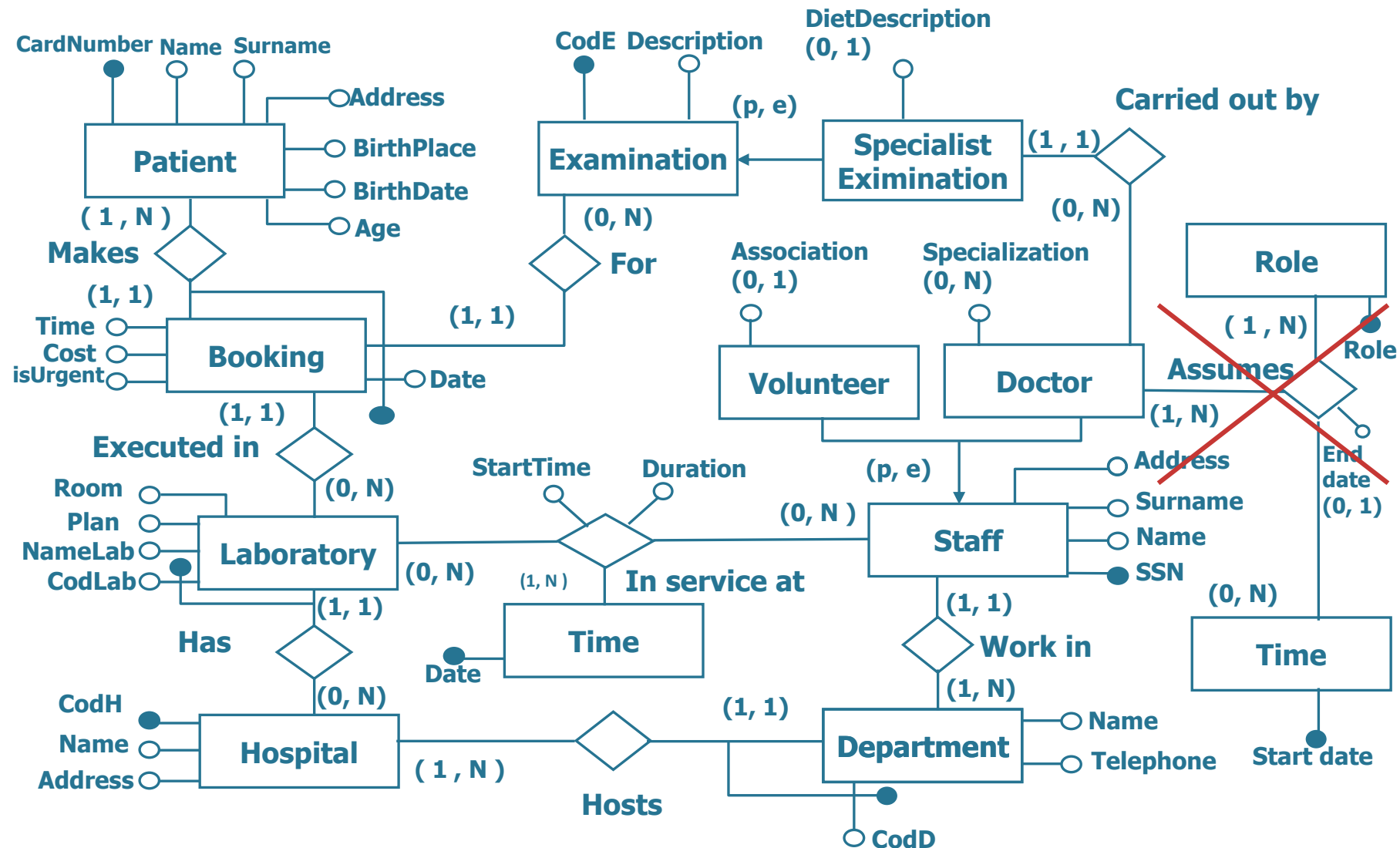
Constraints on the *Assumes* relationship

- Each doctor can take on different roles during his/her career (e.g. assistant, head physician, etc.).

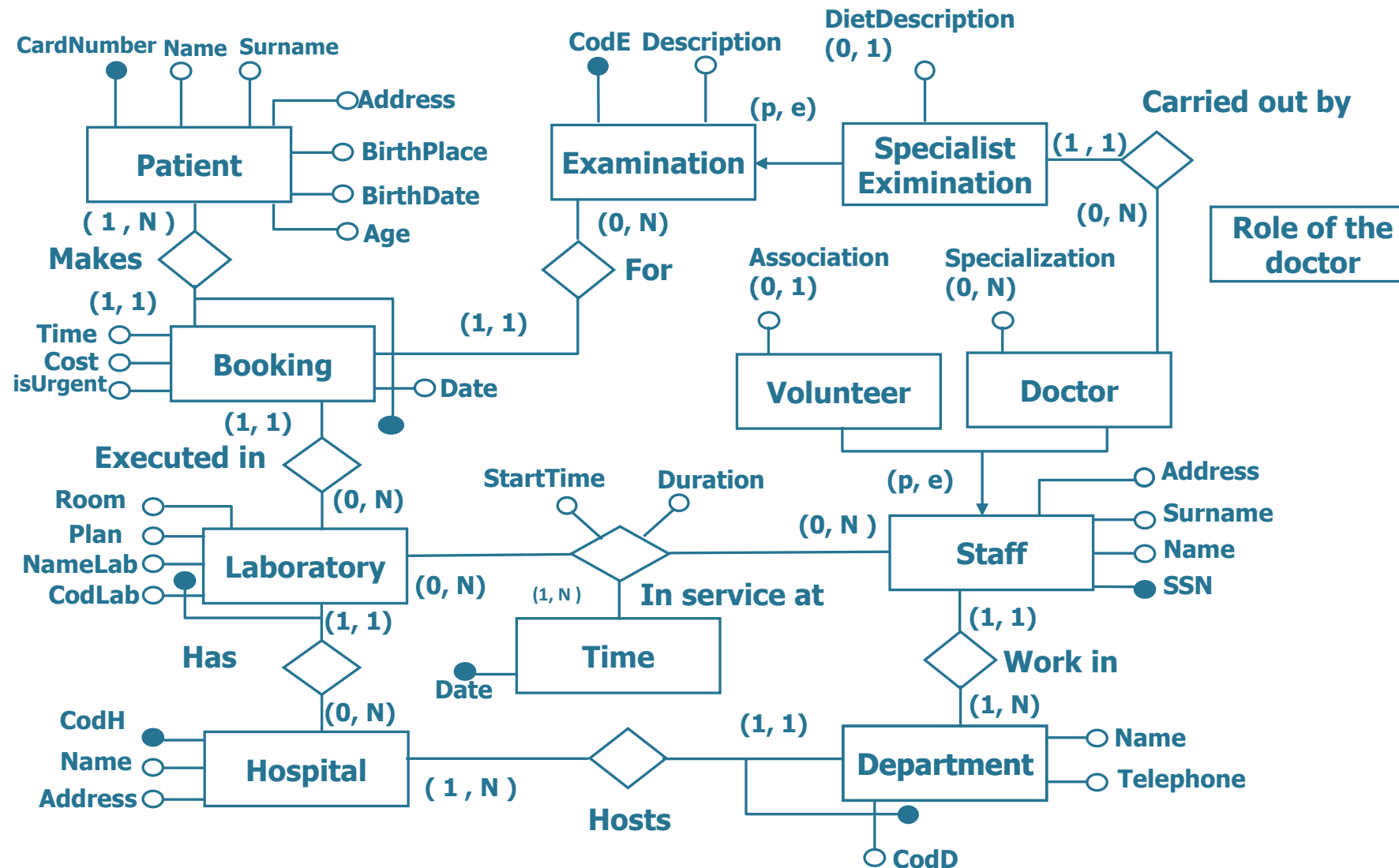
We want to keep track of the roles each doctor has taken on during his/her career and the related time periods (start date, end date).

Keep in mind that each doctor cannot take on more than one role at the same time, but he/she can take on the same role in different time periods.

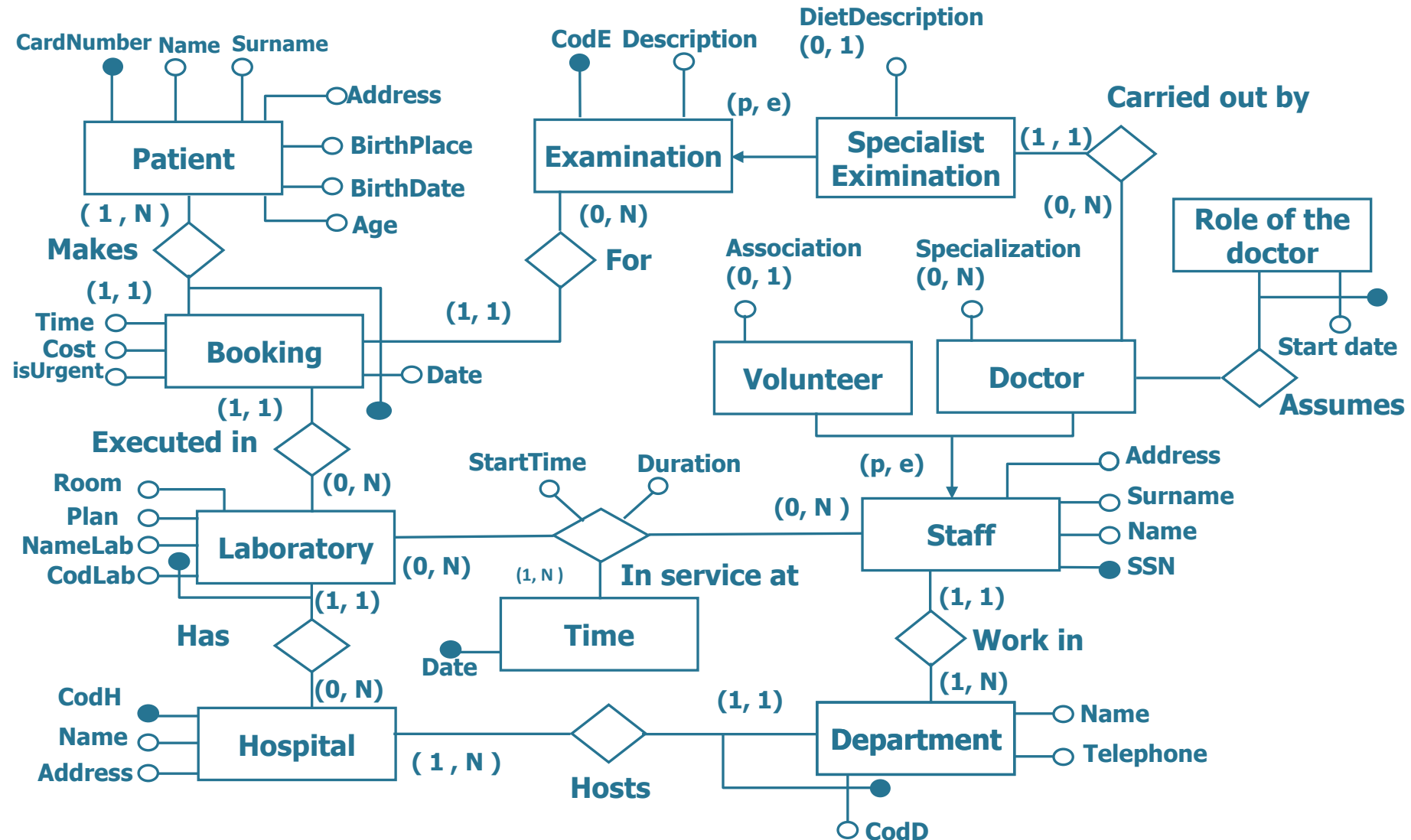
Historicization of the role of the doctor



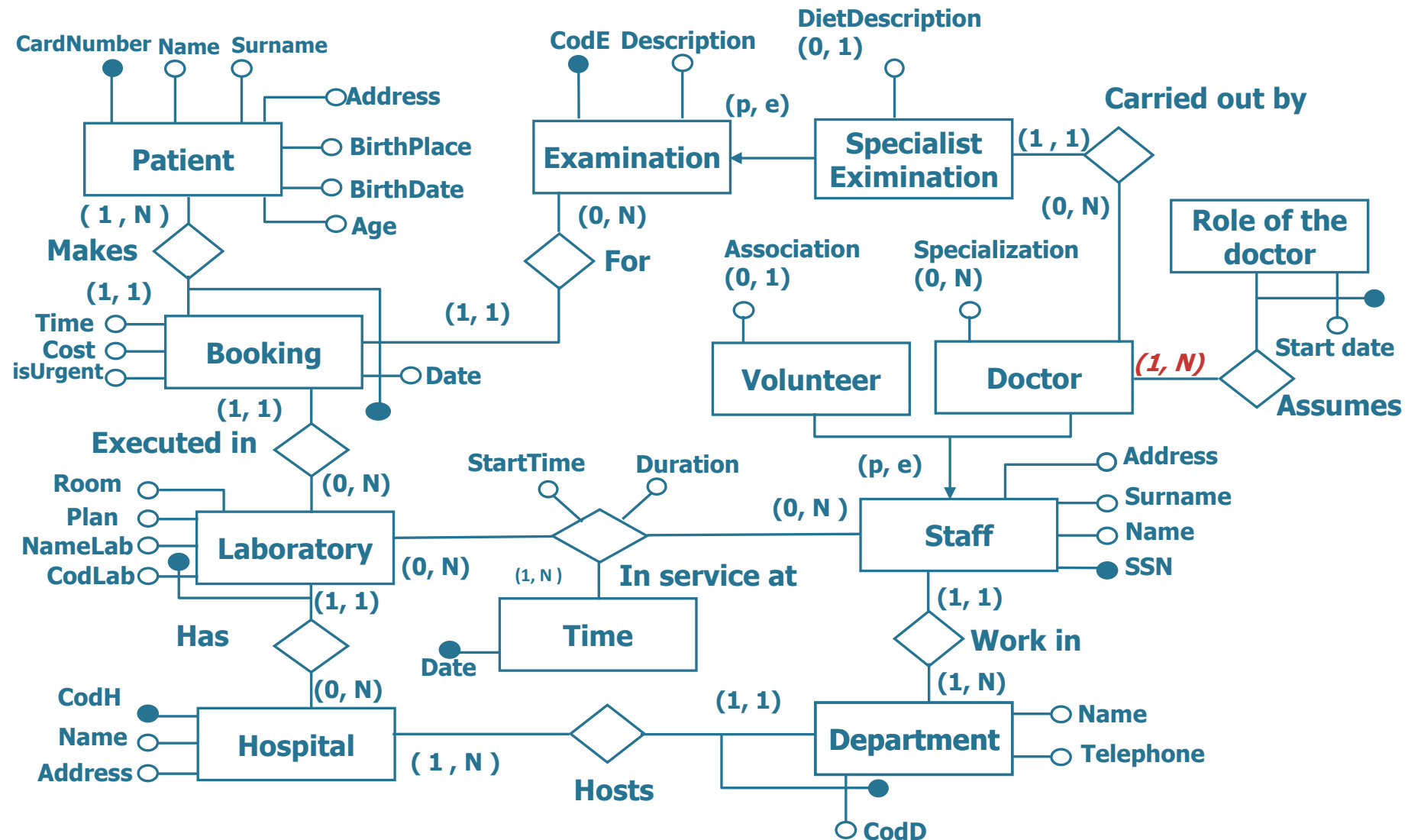
Historicization of the role of the doctor



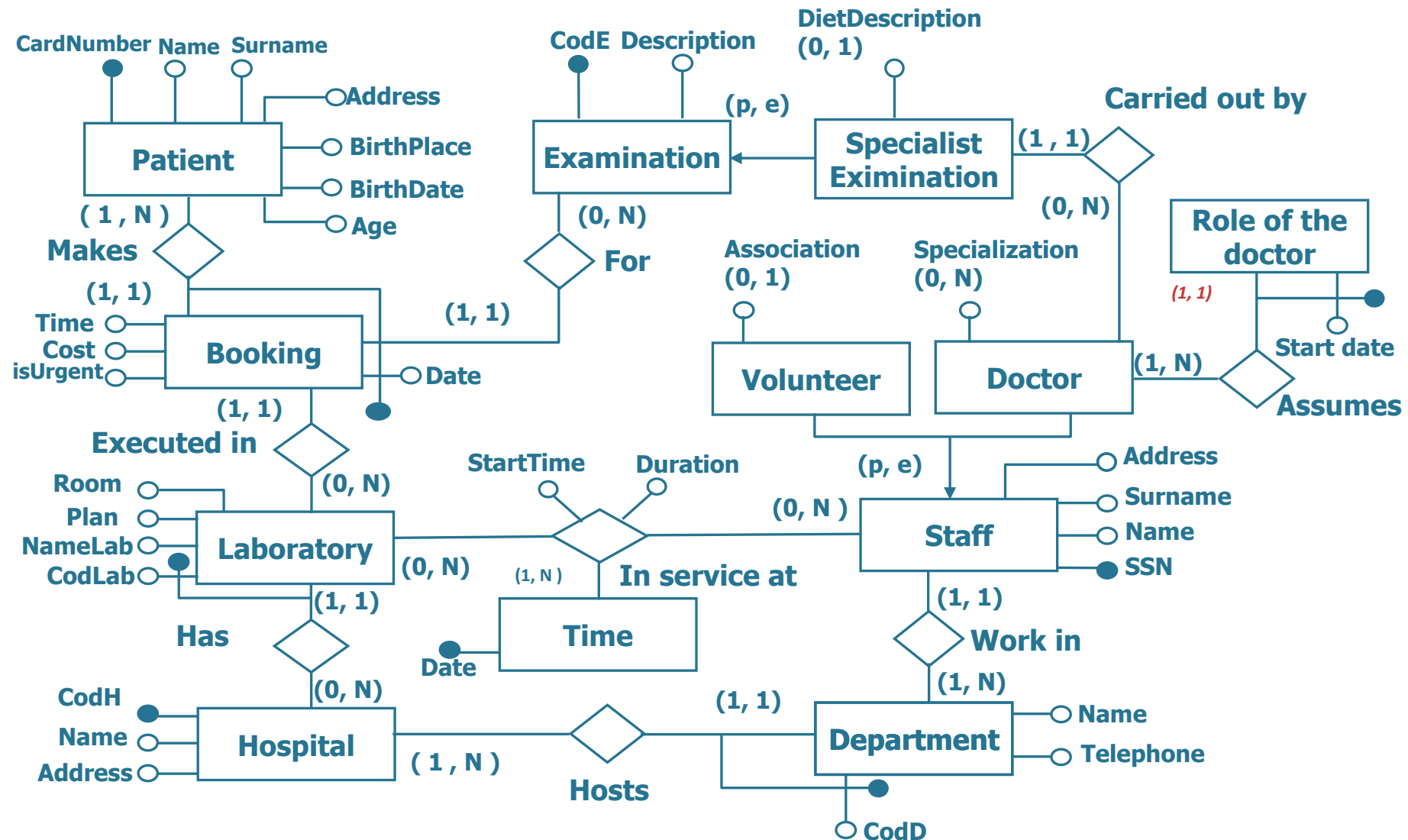
Historicization of the role of the doctor



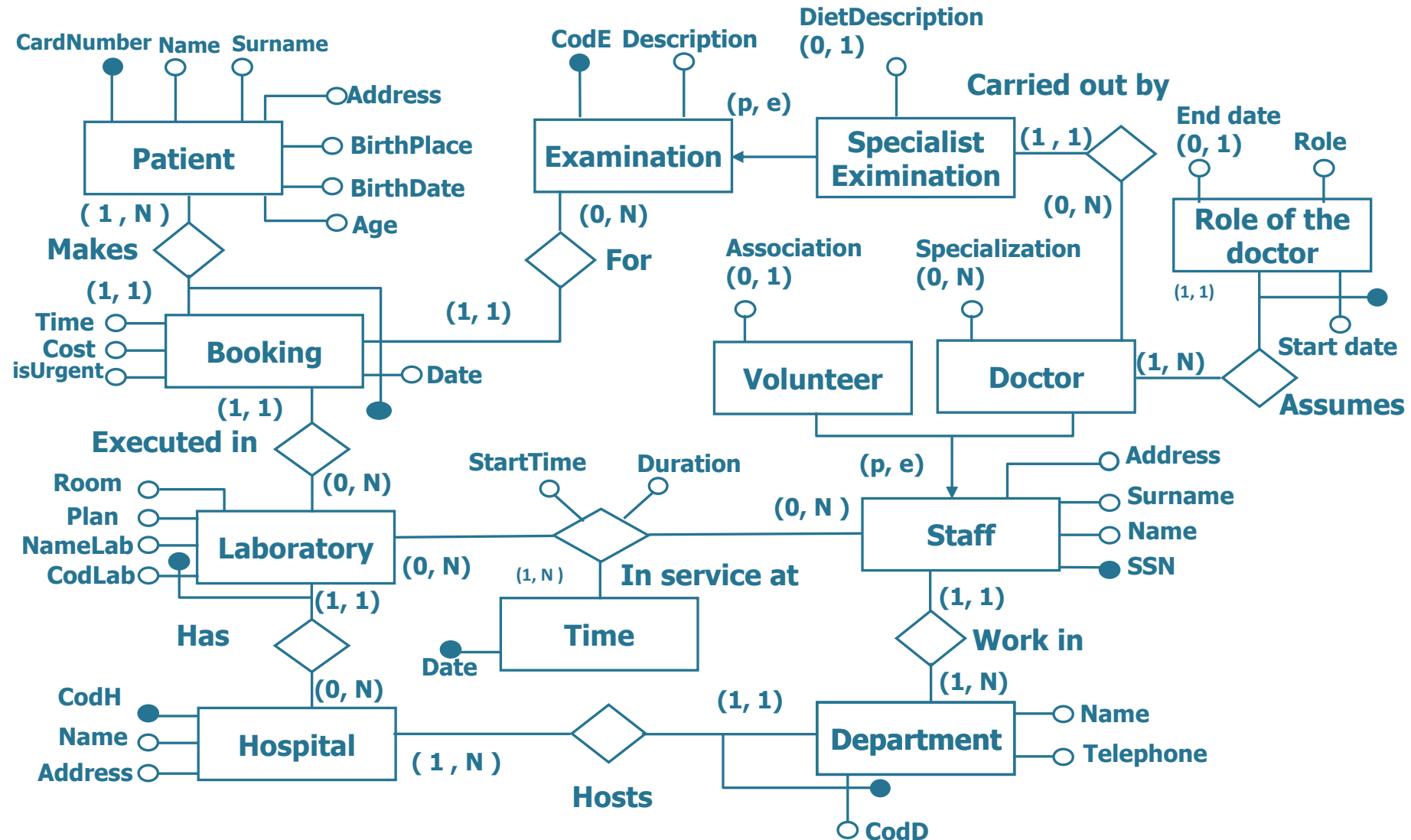
Historicization of the role of the doctor



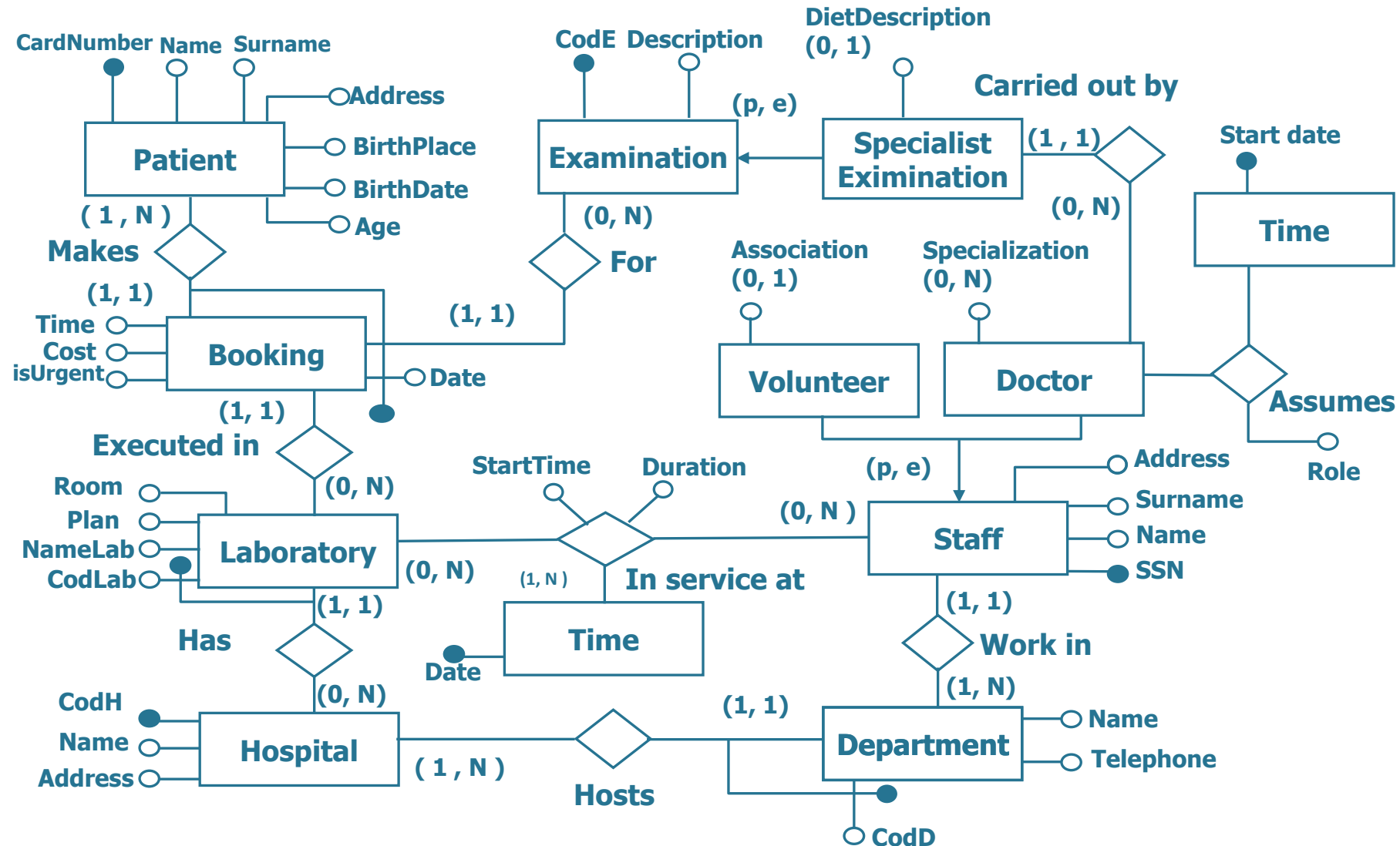
Historicization of the role of the doctor



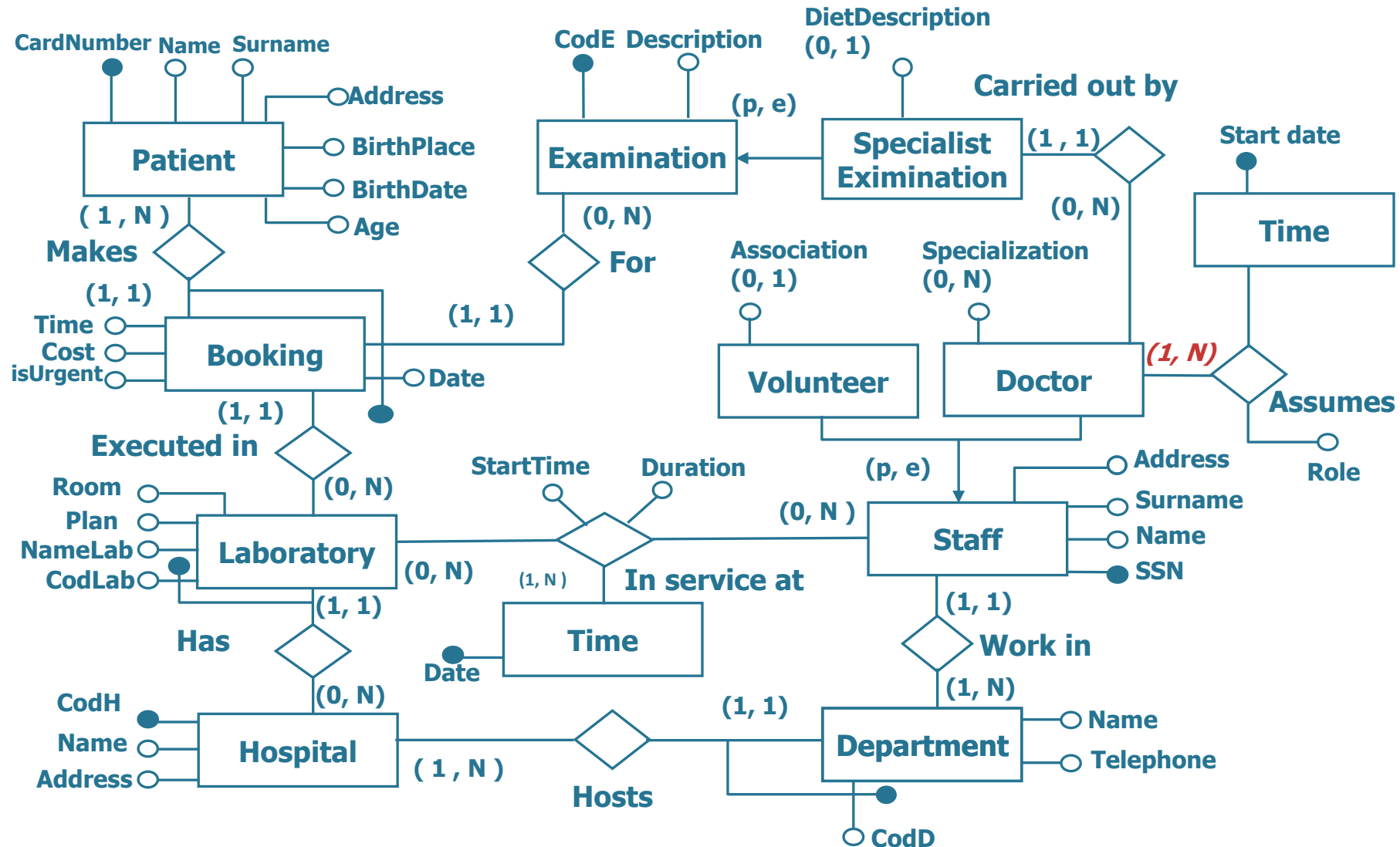
Historicization of the role of the doctor



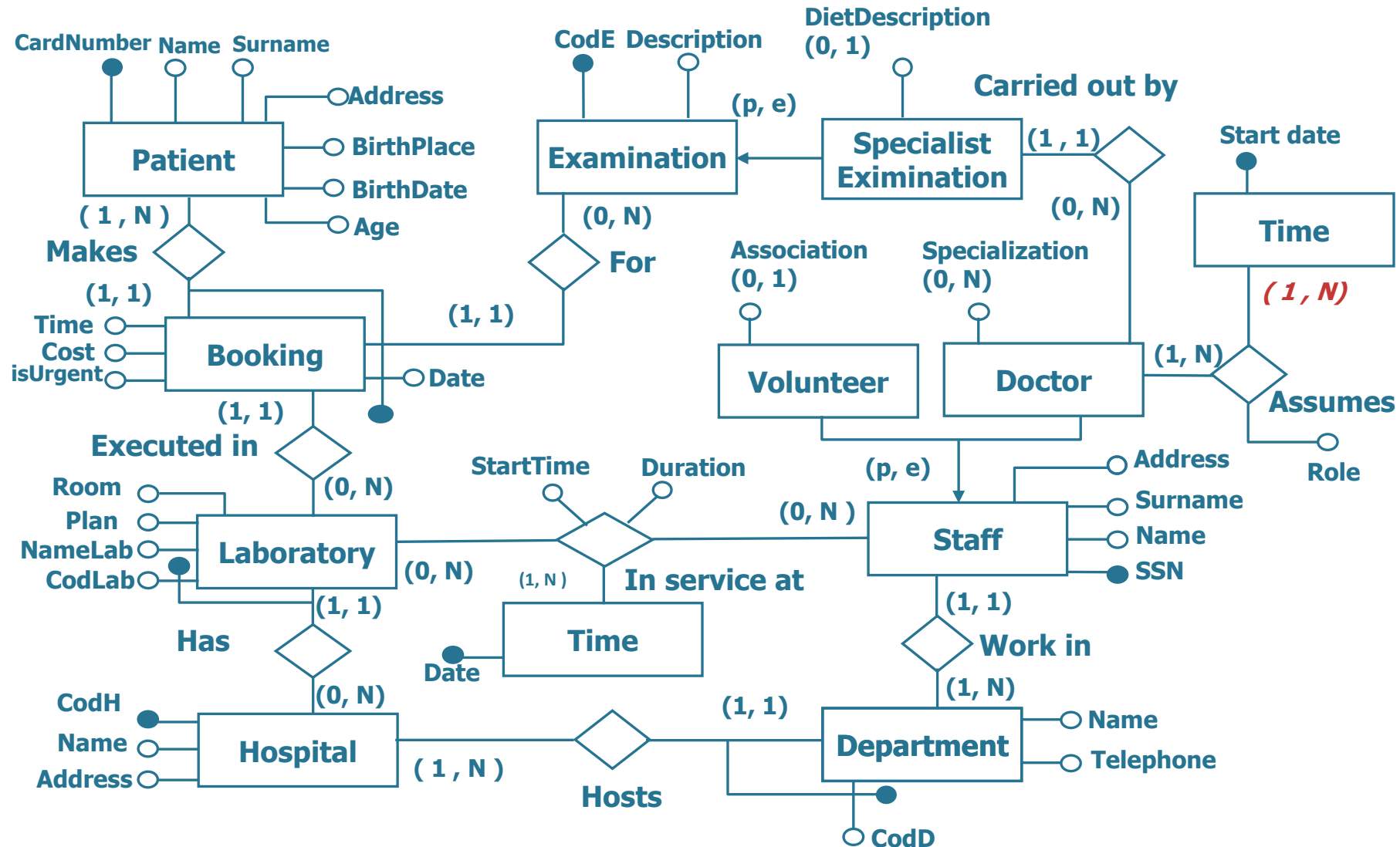
Role history: alternative modeling



Cardinality of the *Assumes* relationship



Cardinality of the *Assumes* relationship



Cardinality of the *Assumes* relationship

