



Relational Database Concepts

Relationship Cardinality

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Objectives

- Understand relationship cardinality.
- Learn ERD Notation basics.
- Understand relationships.



Basic Symbols

- A database is a collection of related data that is organized in a way that it allows this data to be easily retrieved and manipulated. This data is stored in a bunch of tables which are related or linked to remove duplicate data. This makes it easy for you see the data you want when you search instead of seeing all the data at once.
- ERDs are a visual way for the database engineers to understand how all the different parts of the databases are related and how the data will be stored. It is a great way to see the overall design of the database.
- ERDs have three basic elements: entity types, relationships, and attributes.
- Entity types are collections of things of interest or entities) in an application. Entity types represent collections of physical things such as books, people, and places, as well as events such as payments that you want to track in the database.



Representation of Business Rules in an ERD

- As you develop an ERD, you should remember that an ERD contains business rules that enforce organizational policies and promote efficient communication among business stakeholders. These business rules are represented as primary keys, relationships and cardinalities.
- Primary keys support entity identification, an important requirement in business communication.
- Identification dependency involves an entity that depends on other entities for identification, a requirement in some business communication.
- Relationships indicate direct connections among units of business communication.

Basic Symbols

- An entity is a member or instance of an entity type (record or row) and are uniquely identified to allow tracking across business processes. For example, customers have a unique Identification to support order processing, shipment, and product warranty processes. Or Students have a unique identification to support registration processing, course scheduling, faculty assignment processes. A single student is an instance of the entity student
- In the university database we have studied, some of the entities will be courses, students, faculty and these will translate to tables in the database.
- The student entity type for example is a container which will hold many students. Entity means all the things that are like a student will be grouped under student.



Basic Symbols

- This explains why a company such as amazon can keep track of so many customers, their orders and products and also why you get an error that your ideal username for your email account has already been taken.
- In the Crow's Foot notation which is the notation used in the ERD for this course, as well as most other notations, rectangles denote entity types.
- In the university database we have studied, the Course entity type represents the set of courses in the database.
- Attributes are properties of entity types or relationships and become columns in a table. An entity type should have a primary key as well as other descriptive attributes.

Basic Symbols

- Attributes are shown inside an entity type rectangle. If there are many attributes, the attributes can be suppressed and listed on a separate page.
- Underlining indicates that the attribute(s) serves as the primary key of the entity type. The primary key uniquely identifies each instance of the entity to ensure that they are no duplicate values. For example if two students have the same name, they will each have a unique ID that identified them.
- Relationships are named associations among entity types. Meaning that they describe how one or more entities will interact with each other and you do that by drawing a line in between them showing they are connected through a relationship. Usually described as a verb.



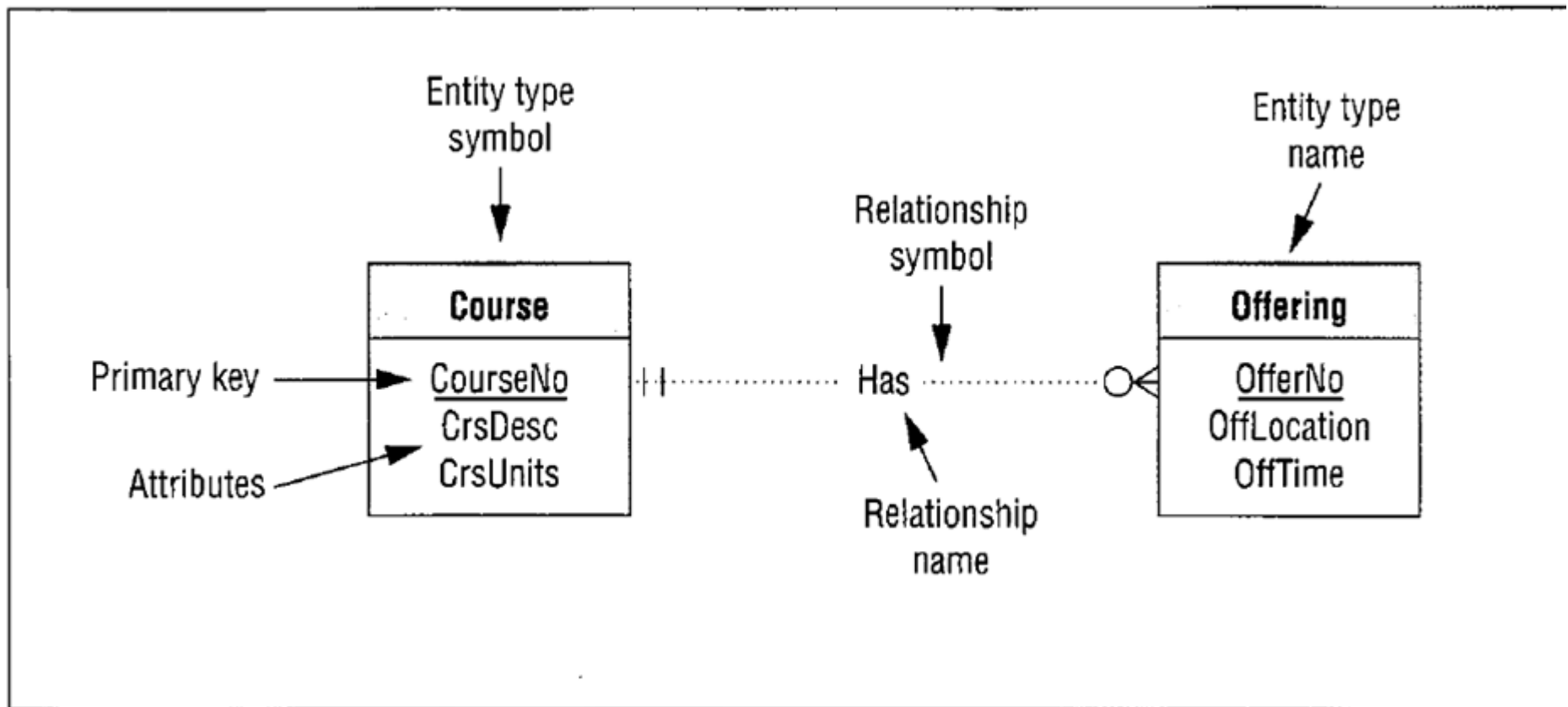
Basic Symbols

- Relationship names appear on the line connecting the entity types involved in the relationship. For example, the Has relationship shows that the Course and Offering entity types are directly related.
- Relationships store associations in both directions. For example, the Has relationship shows the offerings for a given course and the associated course for a given offering.
- The Has relationship is binary because it involves two entity types.

Basic Symbols

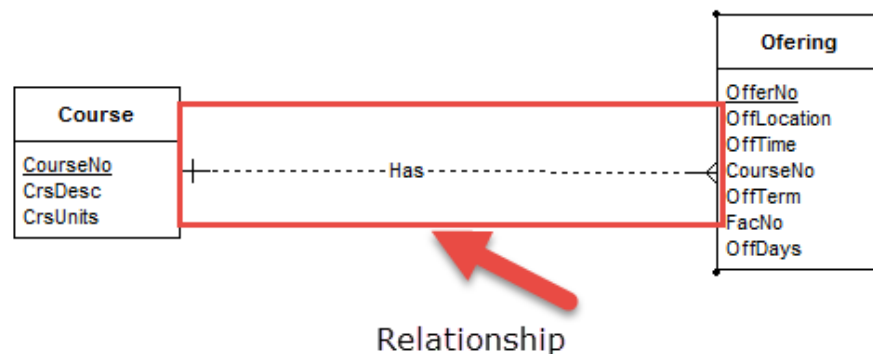
- Entity types can correspond to nouns and relationships to verbs or prepositional phrases connecting nouns. In this sense, one can read an entity relationship diagram as a collection of sentences. read as "course has offerings."
- Note that there is an implied direction in each relationship. In the other direction, one could write, "offering is given for a course."
- The notation attached to the line connecting the entitles in the relationship are called cardinality and further defines the relationship in a numerical context.

Basic Symbols



Basic ERD Notations - Relationships

- Relationships are named associations among entity types. In the Crow's Foot Notation, relationship names appear in the line connecting the entity types involved in a relationship.
- In this ERD, the Has relationship shows that the Course and Offering entity types are directly related or connected.
- Relationships store associations in both directions. For example, the Has relationship shows the offerings for a given course and the associated course for a given offering.



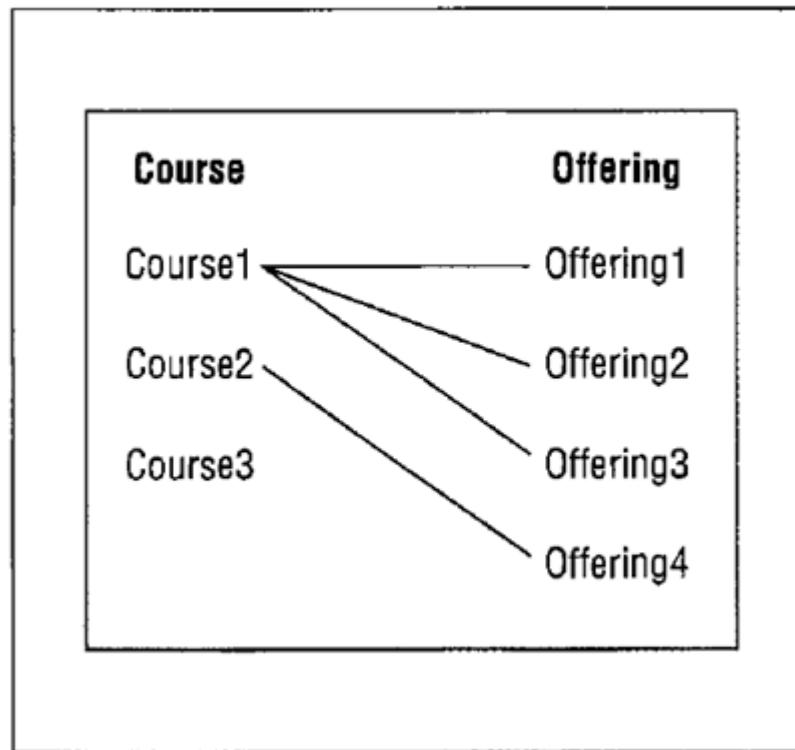


Relationship Cardinality

- Cardinalities restrict the number of objects or entities that participate in a relationship supporting organizational policies and consistent business communication.
- To depict the meaning of cardinalities, an instance diagram is useful.

Relationship Cardinality

- Let's look at our course and offering table, a course can have one or multiple offerings but each offering belongs to one course.



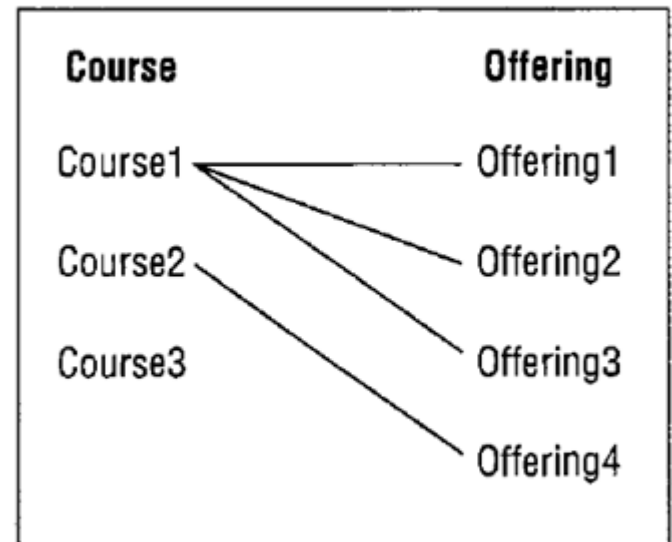


Relationship Cardinality

- Entities will be tables in a database
- An instance of an entity is a row in the table
- Attributes will be columns
- Cardinality tells you how many rows you need from a table before you can link to another table.

Relationship Cardinality

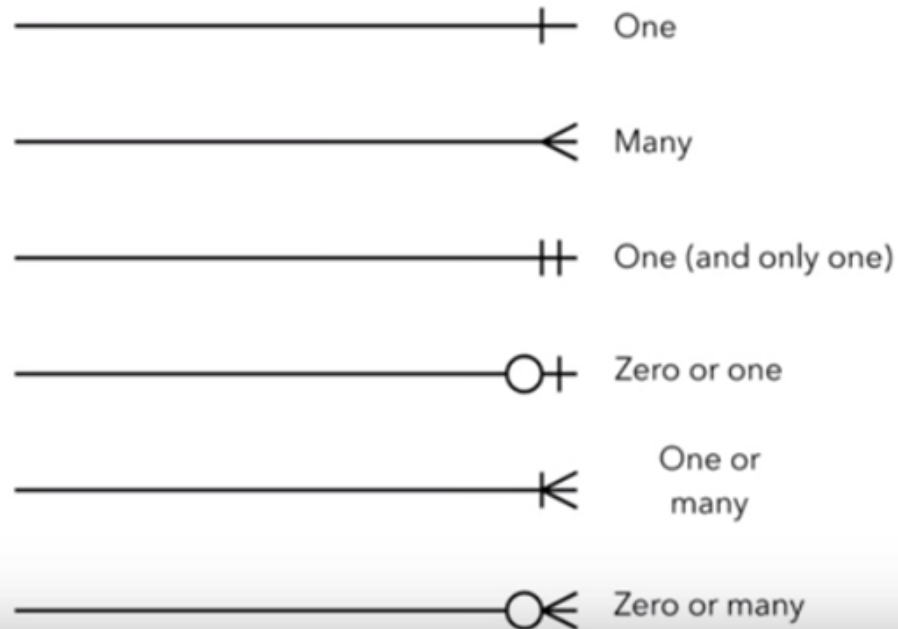
- ({Course1, Course2, Course3}), a set of offerings ({Offering1, Offering2, Offering3, Offering4}), and connections between the two sets. You can see that , Course1 is related to Offering1, Offering2, and Offering3, Course2 is related to Offering4, and Course3 is not related to any Offering entities.
- Likewise, Offering1 is related to Course1, Offering2 is related to Course1, Offering3 is related to Course1, and Offering4 is related to Course2.
- From this instance diagram, we might conclude that each offering is related to exactly one course. In the other direction, each course is related to 0 or more offerings.



Relationship Cardinality

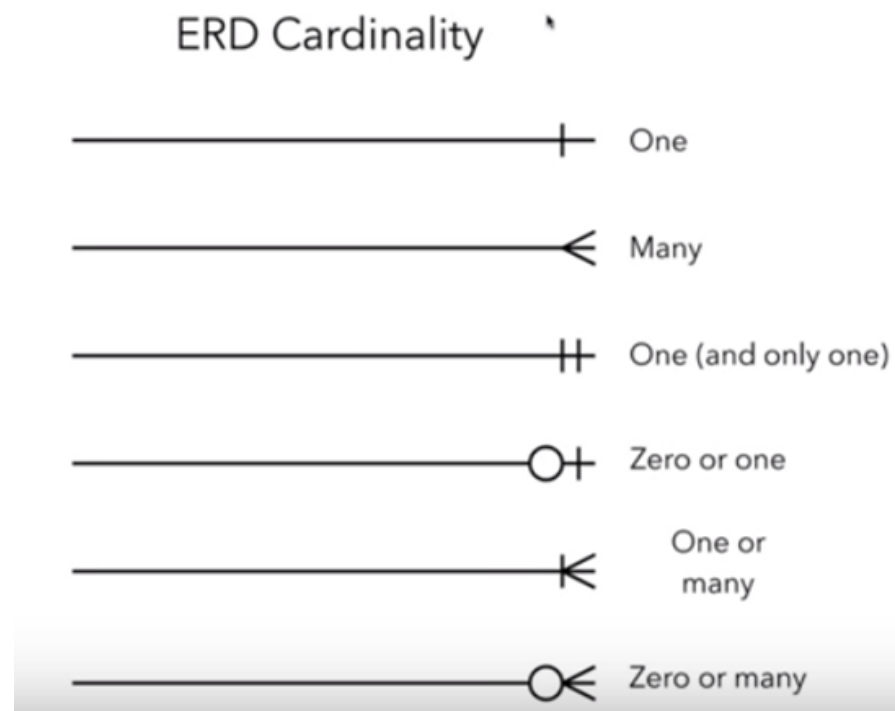
- Cardinality is broken into two parts ..min and max cardinality
- A min cardinality represents the min number of instances that are required in a relationship (fewer number of rows are need for the relationship
- Max cardinality represents the max number of instances that are required in a relationship. Tells us we cannot exceed a certain number of rows in the relationship.

ERD Cardinality



Relationship Cardinality

- The Crow's Foot notation uses symbols to represent cardinalities. The Crow's Foot symbol (two angled lines and one straight line) denotes many (zero or more) related entities.



Relationship Cardinality

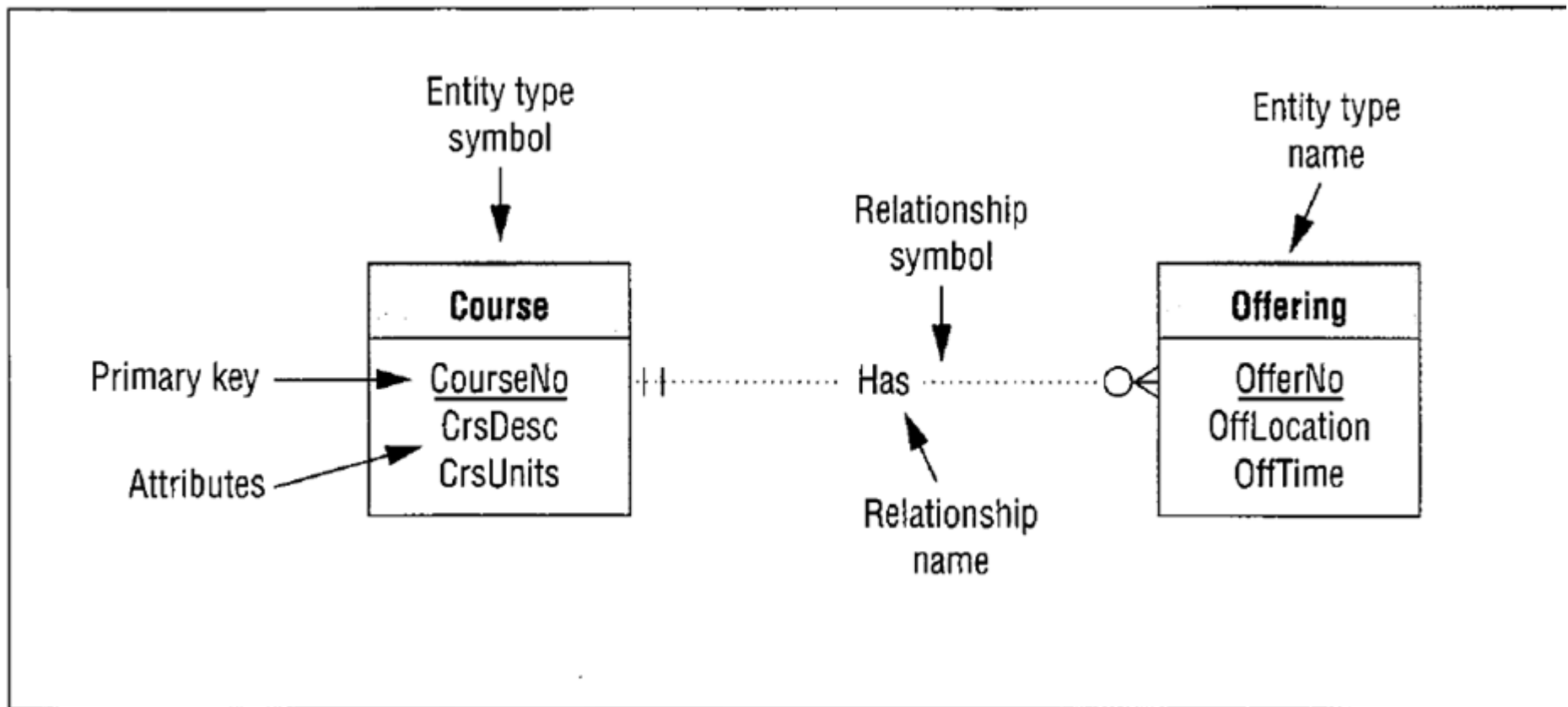
- One mandatory means you must have at least one and only one instance
- Many mandatory - at least one but several instances
- One optional - you don't have to have an instance but if you do, you can only have one
- Many optional - don't have to have an instance but if you do, there is not a limit on how many instances you can have
- The mandatory versus the optional refers to the minimum
- The one vs the many refers to the max

Symbol	Meaning
	One - Mandatory
	Many - Mandatory
	One - Optional
	Many - Optional

Relationship Cardinality

- Lets go back and look at the course and offering tables
- the Crow's Foot symbol near the Offering entity type means that a course can be related to many offerings. The circle means a cardinality of zero, while a line perpendicular to the relationship line means a cardinality of one.
- To depict minimum and maximum cardinalities, the cardinality symbols are placed adjacent to each entity type in a relationship. The minimum cardinality symbol appears toward the relationship name while the maximum cardinality symbol appears toward the entity type.

Relationship Cardinality





Relationship Cardinality

- A course is related to a minimum of zero offerings (circle in the inside position) and a maximum of many offerings (Crow's Foot in the outside position).
- Similarly, an offering is related to exactly one (one and only one) course as shown by the single vertical lines in both inside and outside positions.



Relationship Cardinality

- Cardinalities are classified by common values for minimum and maximum cardinality
- shows two classifications for minimum cardinalities. A minimum cardinality of one or more indicates a mandatory relationship. For example, participation in the Has relationship is mandatory for each Offering entity due to the minimum cardinality of one.
- A mandatory relationship makes the entity type existence dependent on the relationship.
- The Offering entity type depends on the Has relationship because an Offering entity cannot be stored without a related Course entity.



Relationship Cardinality

- In contrast, a minimum cardinality of zero indicates an optional relationship. For example, the Has relationship is optional to the Course entity type because a Course entity can be stored without being related to an Offering entity.



Relationship Cardinality

- A maximum cardinality of one means the relationship is single-valued or functional. For example, the Has and Teaches relationships are functional for Offering because an Offering entity can be related to a maximum of one Course and one Faculty entity.
- The word function comes from mathematics where a function gives one value. A relationship that has a maximum cardinality of one in one direction and more than one (many) in the other direction is called a 1-M (read one-to-many) relationship. Both the Has and Teaches relationships are 1-M.
- Similarly, a relationship that has a maximum cardinality of more than one in both directions is known as an M-N (many-to-many) relationship.

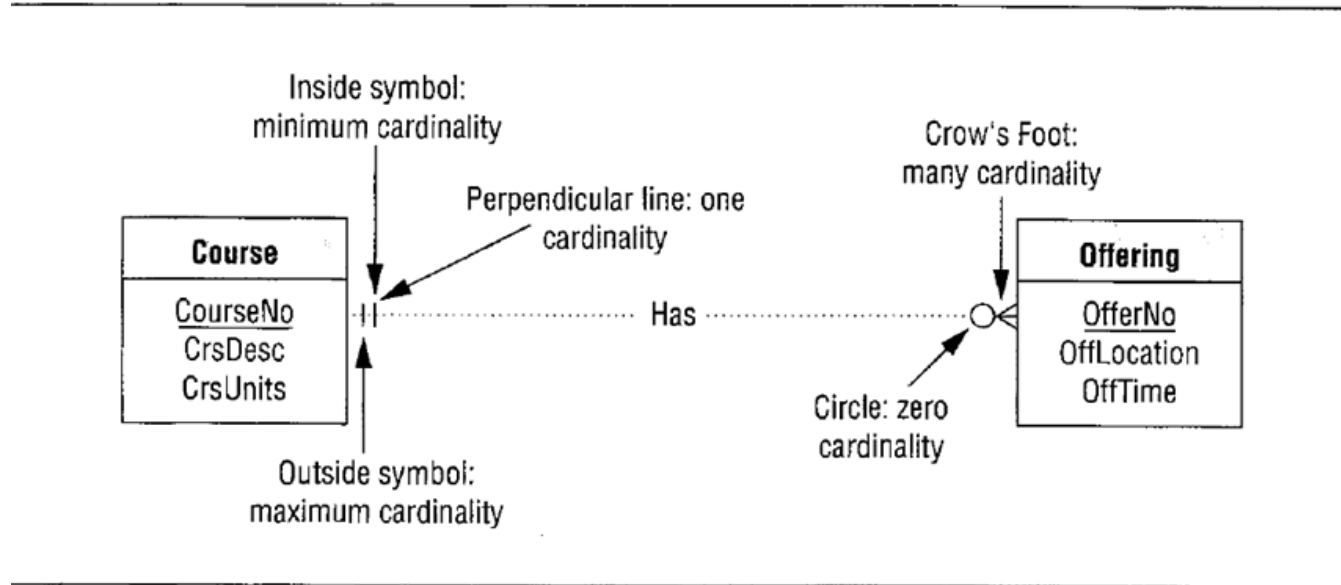


Business rules

- Now lets apply some examples to ERD and business rules.

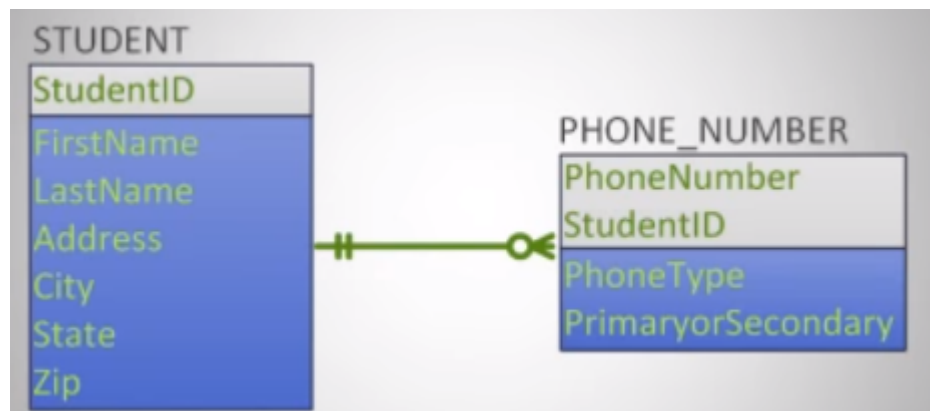
Example 1

- What are business rules: Rules defined in an organization supporting organizational policies and consistent business communication.
- Business rule example : A course can have one or many offerings and an offering is given for a course



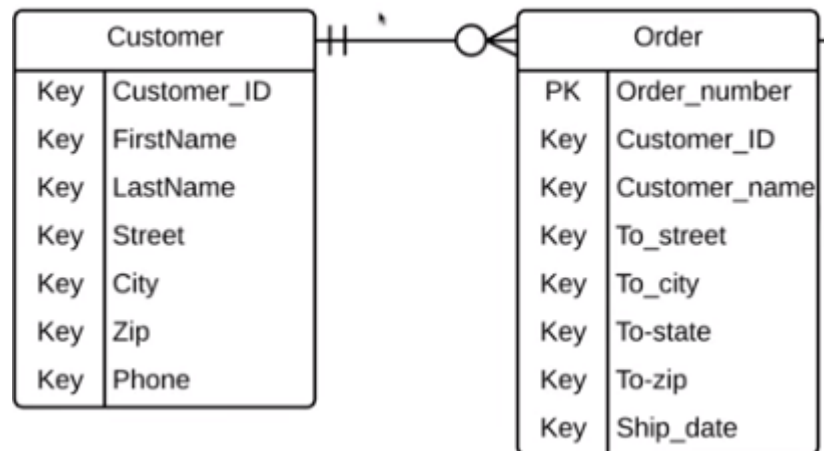
Example 2

- Business rule :A student can have one or many phone numbers.
- It is optional for a student to have a phone number in one direction or they may or may not have a telephone number, however it is mandatory that a phone number is connected to a student.



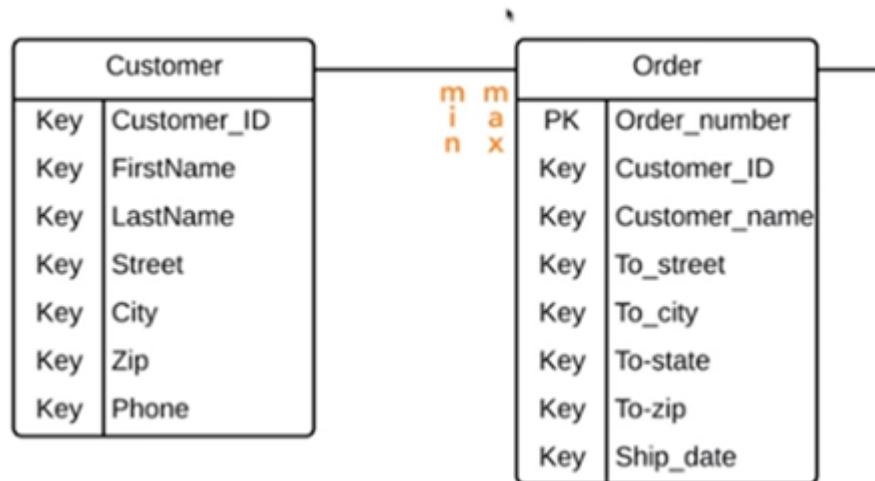
Example 3

- Whats the min number of orders a customer could have – a customer could exist, but can have zero orders
- What are the max number of orders a customer could have – a customer could have one or many orders. To show this, use the zero or many crows foot notation.
- Now lets talk about the min and max relation between orders and customers:
- What is the min amount of orders a customer can have?
- What's the max amount of orders that a customer can have?



Example 3

- A specific order can only have one and only one customer – imagine the confusion if the same specific order had many customers. In this case, there can be only one and only one customer to an order.



THANK YOU

Questions?