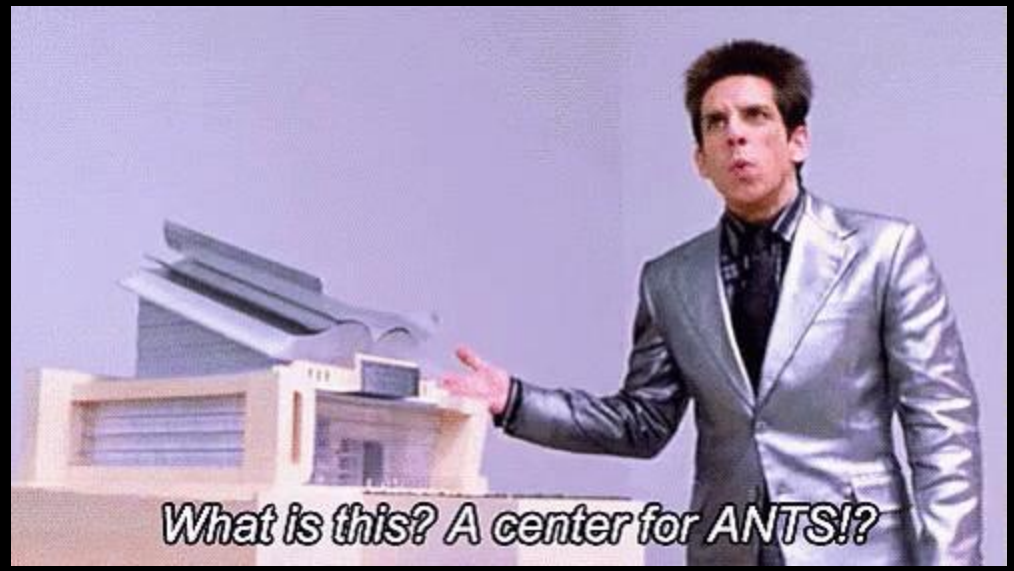
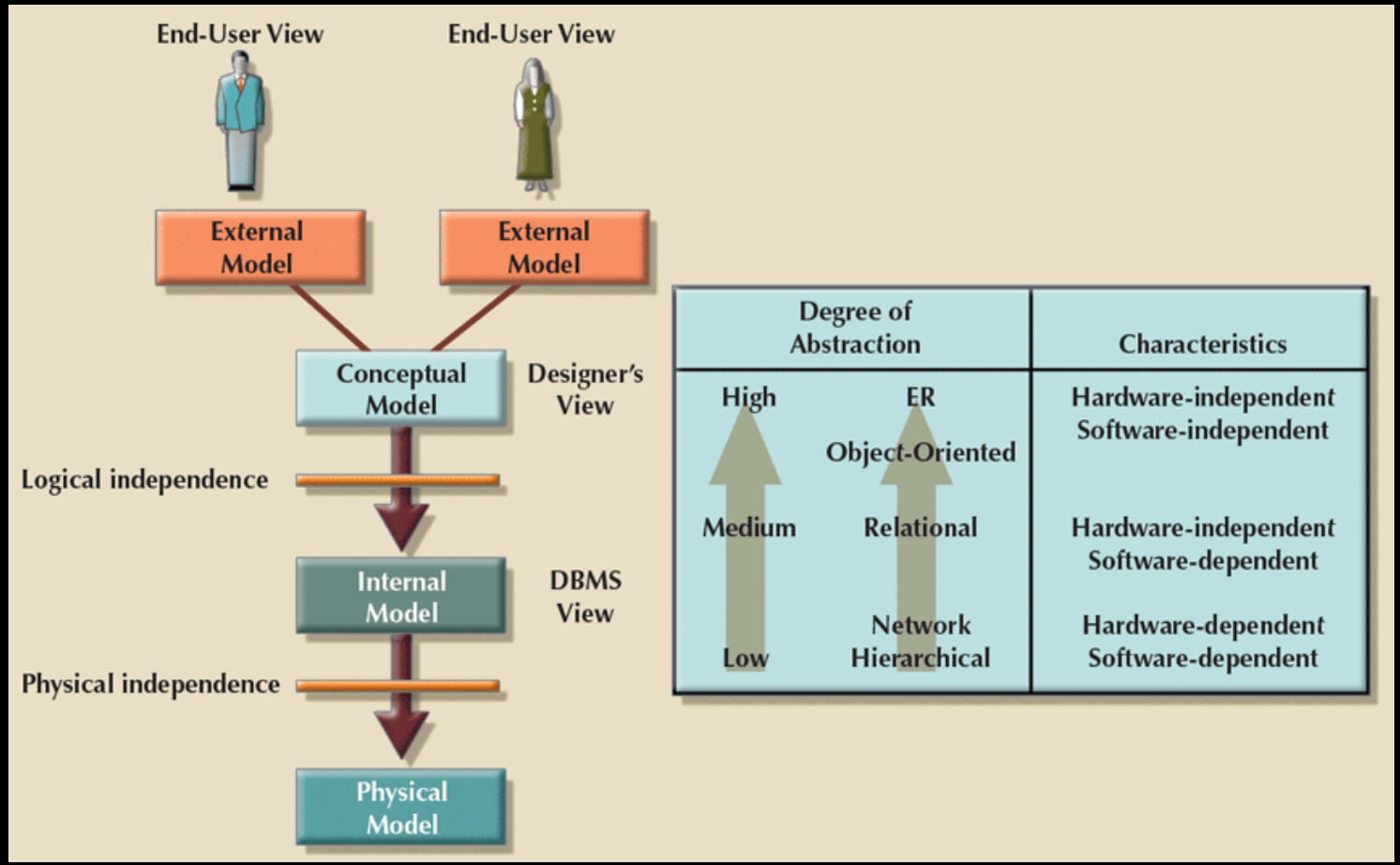
Data Models

- Model – abstraction of a more complex real-world object or event
- Data model – representation of complex real-world data structures
- Data modeling – creating a specific representation for a determined problem domain
- Importance
  - Facilitates communication
  - Provides various views of the DB
  - Organizes data for various users
  - An abstraction for creating a good DB



Degrees of Abstraction



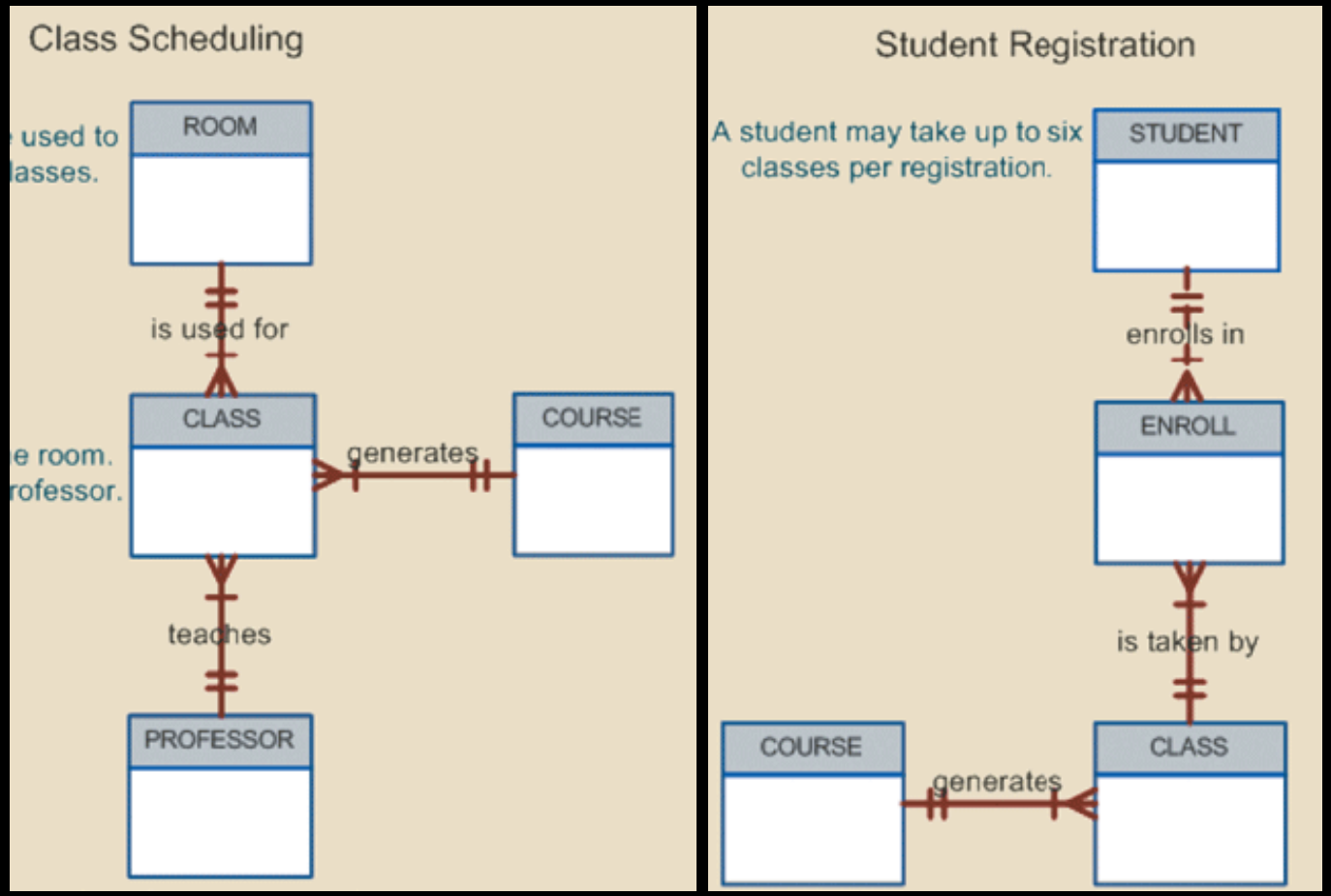
Degree of Abstraction		Characteristics
High	ER	Hardware-independent Software-independent
	Object-Oriented	
Medium	Relational	Hardware-independent Software-dependent
	Network	Hardware-dependent Software-dependent
Low	Hierarchical	

Degrees of Abstraction

- External Model
  - End user's view
  - People use applications to manipulate data and generate information
  - Represented by an ERD
  - External schema – specific representation of an external view
- Conceptual Model
  - Global view (macro-level view) of entire database by the organization
  - Conceptual schema – identification & high-level description of data objects
  - Logical design – creating a conceptual model
  - Represented by an ERD
  - Software and hardware independent

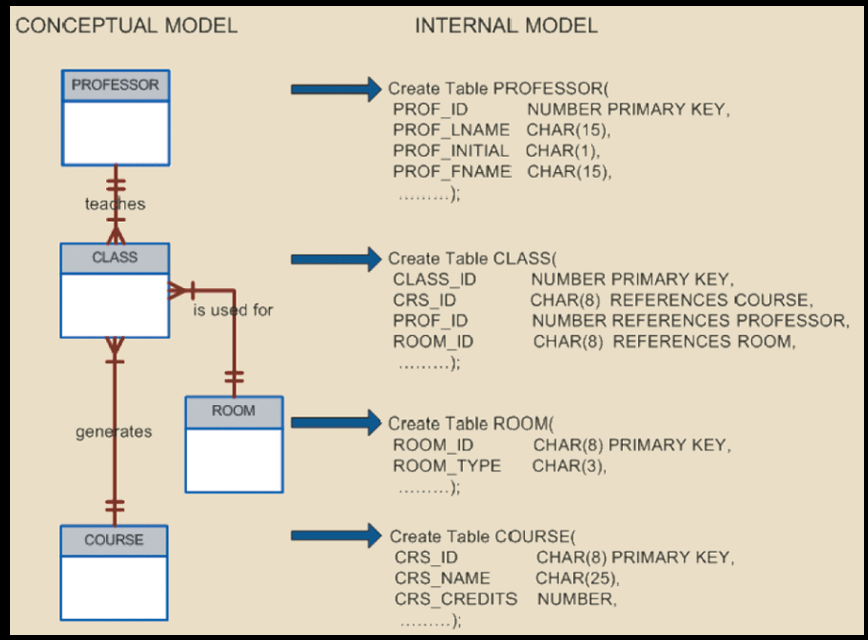
Degrees of Abstraction

- External Model



Degrees of Abstraction

- Internal model
  - Maps the conceptual model to the DBMS internal schema representation
  - Internal schema
    - Specific representation of an internal model
    - Using constructs supported by the database
  - Logical independence – changing the internal model doesn't affect the conceptional model
  - Hardware independent – unaffected by the type of hardware it is on



Degrees of Abstraction

- Physical model
  - Lowest level of abstraction
  - Describes how data is saved on storage media
  - Requires the definition of physical storage and data access methods
  - Software and hardware dependent

Basic Building Blocks

- Entity – person, place, thing, or event about which data will be collected and stored (think of a table)
- Entity instance – one entity occurrence (think of a table row)
- Attribute – characteristic of an entity (think of a table column)
  - Attribute domain – set of possible values for an attribute
- Relationship – association among entities (think of a link among tables)
- Constraint – restriction placed on data to ensure data integrity

Relational Model

- Relation – matrix composed of intersecting tuples and attributes
  - Relation – table or entity
  - Tuple – row, entity occurrence, or entity instance
  - Attribute – column or characteristic
- Relationship - association among relations (connectivity)
  - One-to-many (1:M)
  - Many-to-many (M:N)
  - One-to-one (1:1)

Business Rules

- Description of a policy, procedure, or principle
- Brief, precise, and unambiguous
- Create and enforce actions within that organization’s environment
- Standardizes the company’s view of data
- Facilitates communication between users and designers
- Assists designers to
  - Understand the nature, role, scope of data, and business processes
  - Develop appropriate relationship participation rules and constraints
  - Create an accurate data model
- Establishes entities, relationships, and constraints, and processes

Business Rules

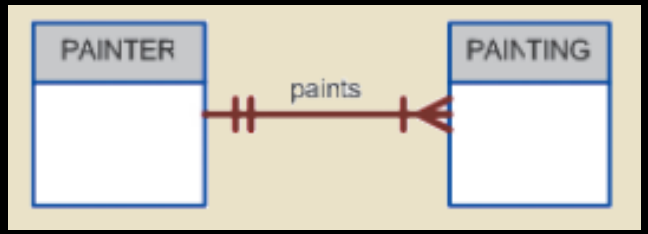
- Translating business rules into data model components
  - Nouns → entities
  - Verbs → relationships between entities
  - Adjectives of the relationship → relationship type and cardinality
  - Characteristics of a noun → entity attributes
  - Descriptions of a characteristic → attribute constraints and domains
  - Descriptions of events that occur involving entities → process
  - Descriptions of events that occur involving the DBMS → process
- Note: Need to think carefully about the context to understand how to use the business rule in designing

Business Rules Examples

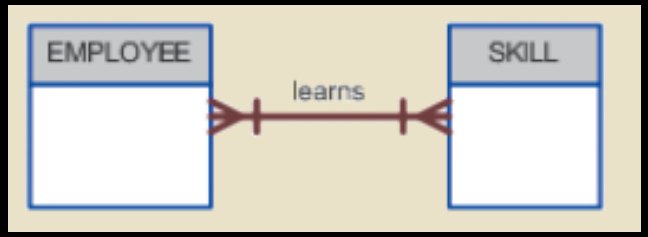
- A customer may generate many invoices.
  - Customer and invoice are entities
  - Generate is the relationship
  - May generate many – 1:M (technically 0:M)
- An invoice is generated by only one customer.
  - Invoice and customer are entities
  - An invoice generated by only one – 1:1
- A customer has an ID of nine digits, first name, last name, phone number.
  - ID, first name, last name, phone number are entity attributes
  - ID attribute domain is a value between 100000000 to 999999999
  - Others may be implied by or need clarification, e.g., name and phone number

Business Rules Examples

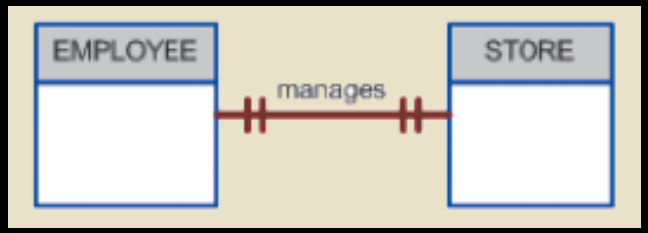
- A painter paints many paintings.
- Each painting is painted by one painter.



- An employee learns many skills.
- Each skill can be learned by many employees.



- An employee manages one store.
- Each store is managed by one employee.



Business Rules Examples

- A transfer subtracts money from one account and adds it to one other
  - Process that updates two different accounts, leaving them in balance

- The maintenance schedule is every Saturday beginning at 6 am CST
  - Process that entails some type of maintenance to the system
  - Constrains the maintenance to start on Saturday morning

- Note: There are often hidden constraints and vagueness that need defining, questions that need answers, and details that are missing.

Business Rules Naming Conventions

- Proper naming is important
  - Facilitates communication between parties
  - Promotes self-documentation
  - Be descriptive of the item
  - Use terminology familiar to the users

- It does not matter what you think something should be named because you must match what the organization uses.

Business Rules – Writing Examples

- Write the business rules that govern the relationship between an agent and a customer.

Table name: AGENT (first six attributes) **Database name: Ch02_InsureCo**

AGENT_CODE	AGENT_LNAME	AGENT_FNAME	AGENT_INITIAL	AGENT_AREACODE	AGENT_PHONE
501	Alby	Alex	B	713	228-1249
502	Hahn	Leah	F	615	882-1244
503	Okon	John	T	615	123-5589

Link through AGENT_CODE

Table name: CUSTOMER

CUS_CODE	CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE	CUS_INSURE_TYPE	CUS_INSURE_AMT	CUS_RENEW_DATE	AGENT_CODE
10010	Ramas	Alfred	A	615	844-2573	T1	100.00	05-Apr-2018	502
10011	Dunne	Leona	K	713	894-1238	T1	250.00	16-Jun-2018	501
10012	Smith	Kathy	W	615	894-2285	S2	150.00	29-Jan-2019	502
10013	Olowski	Paul	F	615	894-2180	S1	300.00	14-Oct-2018	502
10014	Orlando	Myron		615	222-1672	T1	100.00	28-Dec-2019	501
10015	O'Brian	Amy	B	713	442-3381	T2	850.00	22-Sep-2018	503
10016	Brown	James	G	615	297-1228	S1	120.00	25-Mar-2019	502
10017	Williams	George		615	290-2556	S1	250.00	17-Jul-2018	503
10018	Farriss	Anne	G	713	382-7185	T2	100.00	03-Dec-2018	501
10019	Smith	Olette	K	615	297-3809	S2	500.00	14-Mar-2019	503

Business Rules – Writing Examples

- One agent can have many customers.
- Each customer has only one agent.

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Business Rules – Writing Examples

- An agent has a numeric code, last name, first name, middle name initial, and a phone number with area code.
- Agent code is a three-digit integer. (*right justify suggests number*)
- Name are strings of variable length with unknown length limit.
- Middle name initial is one character.
- Area code is a three-digit string without parentheses. (*left justify*)
- A phone number is a string formatted as three-digits followed by a dash and four digits.

Other business rules?

Notice our assumptions?

Table name: AGENT (first six attributes)

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Business Rules – Writing Examples

The local city youth league needs a database system to help keep track of children who sign up to play soccer. It must hold data on each team, player, coach, and guardian. A team has an ID, name, and team colors. A player has an ID, first name, last name, and age. A coach has an ID, first name, last name, and phone number. A guardian has an ID, first name, last name, address, and phone numbers for home and cell phones. Note that the guardian does not require both phone numbers, but they must have at least one of them.

A player can only play for one team. While we typically assume that a team must have players, it is possible that a team temporarily has no players and a maximum of 15 players. It is possible that a team temporarily does not have a coach, but if there is a coach, the coach can only be on that team. A team can have up to three coaches.

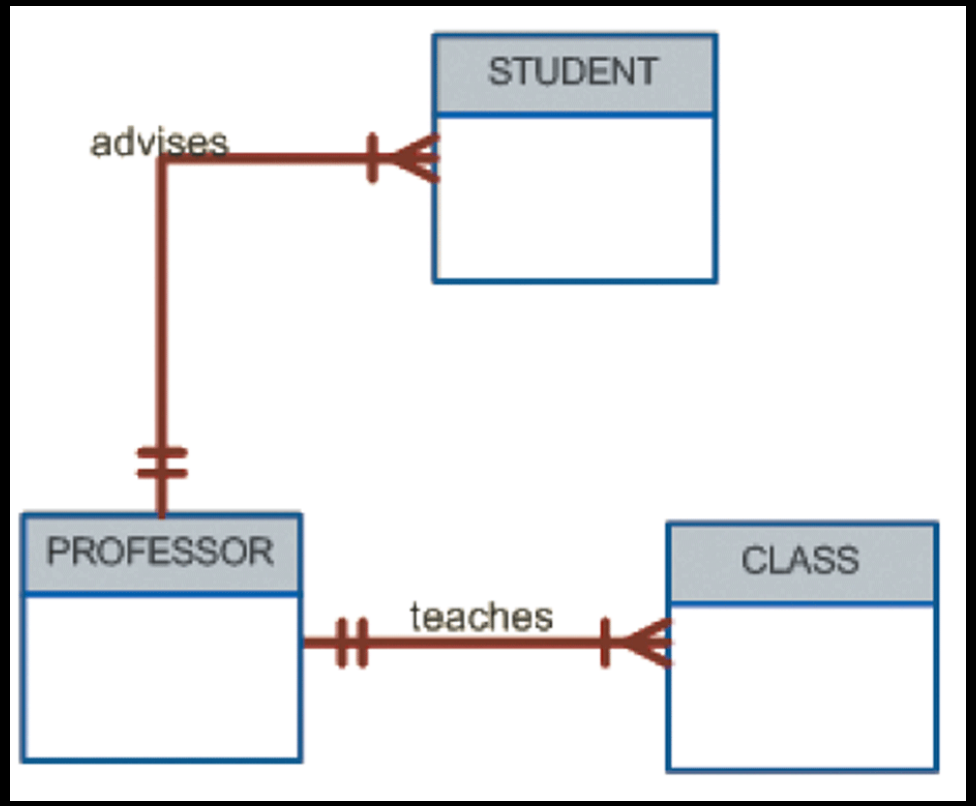
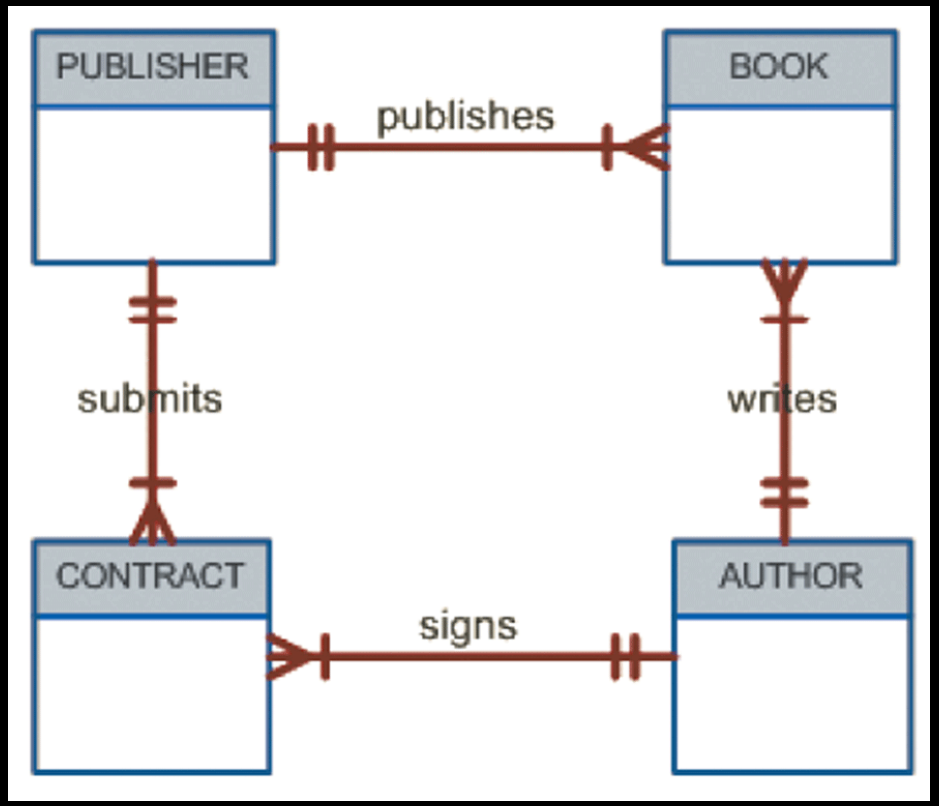
The player must have at least one guardian but can have up to two. Several players can have the same guardians, and those players could be on the same team.

Business Rules – Writing Examples

- A team has an ID, name, and team colors.
- A player has an ID, first name, last name, and age.
- A coach has an ID, first name, last name, and phone number.
- A guardian has an ID, first name, last name, address, and home and cell phone numbers.
- A team has many players. A player is on one team.
- A team is coached by many coaches. A coach coaches one team.
- A player has many guardians. A guardian can have many players.
- A team has 0 to 15 players.
- A team has 0 to 3 coaches.
- A player must have 1 to 2 guardians.
- Related players can be on the same team.
- A guardian must have a home number, cell phone number, or both.

Others?

How correct are they?

Entity-Relation Diagrams (ERD)

- Business rules help us design the database.