# Database

Entities and Their Relationships

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# Let's Get Start

- To design a Relational Database, we start with an Entity Relationship Model (ER Model):
  - Describes what are the entities the database is going to record
  - Describes what are the attributes (and identifiers) of the entities
  - Describes how the relationships among these entities
  - To represent the Entity Relational Model in an explicit way, we the Entity Relationship Diagram

# Entity Relationship Model

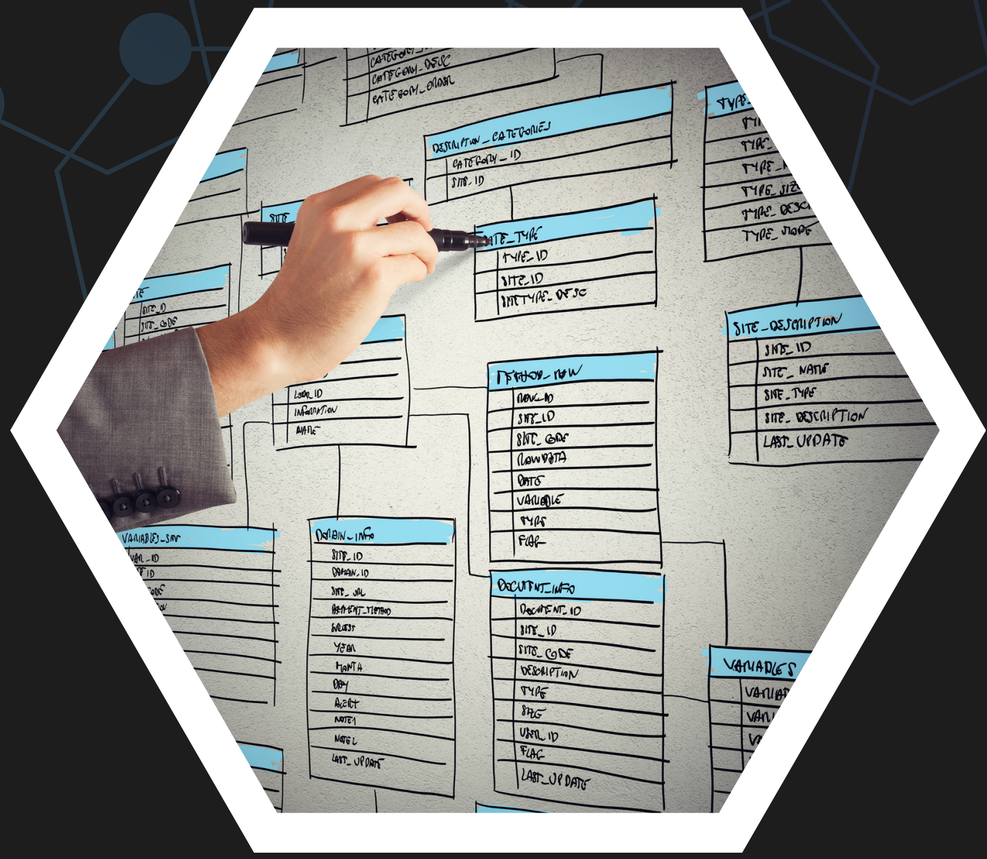
- An Entity Relationship model (or ER model) describes interrelated things of interest in a specific domain of knowledge
- Concepts
  - Entity
  - Attribute
  - Identifier
  - Relationship

# Entity

- The identifiable abstract object of interest (in programming, we call Class)
- Example
  - Students
  - Employees
  - Companies
  - Products
  - Transactions

# Attributes

- Characteristics of an entity of interest
- Example
  - Students: FirstName, StudentID, Major
  - Employees: ID, SSN, ContactInfo
  - Companies: LegalName, Location, Category
  - Products: SKU#, Category, InStockPrice
  - Transaction: CustomerID, StoreID, ProductID



# Instance

- A record/ member of an entity of interest (with the actual value of attributes)
- Example
  - A student: FirstName= "Joe", StudentID = "DB001"

# Identifiers

- A special attribute used to identify a specific instance of an entity
  - Maybe natural (your DBMS doesn't need to create it): SSN
  - Maybe artificial (your DBMS needs to create it): EmployeeID

# Question


**which one can be used as Identifier?**

- Students: FirstName, StudentID, Major
- Employees: ID, SSN, ContactInfo, Department, Supervisor
- Companies: LegalName, Location, Category, Rank
- Products: SKU#, Category, InStockPrice, InStockQuantity

# Relationship

- An association between two (or more) entities
  - More specifically, how the members of two (or more) entities are connected. Usually, we name a relationship with a verb.
- Example:
  - Employees and Companies
    - How many companies can an employee work for?
    - How many employees can a company have?

# Relationship - Degree

- A Relationship can include one or more entities.
- The degree of a relationship is the number of entities participating.
- Relationships of degree 1 are called **Unary** relationships (also called Recursive)
- Relationships of degree 2 are called Binary relationships. Most relationships in databases are Binary.

# Relationship - Cardinality

- Cardinality refers to the number of instances of the entities involved in the relationship.
  - Also called max cardinality/ multiplicity of a relationship
- There are three types:
  - 1:1 (also called One to One)
  - 1:N (also called One to Many)
  - N:M (also called Many to Many)

# Relationship - Participation

- Participation of instances in a relationship, maybe mandatory or optional
  - Also called optionality, minimal cardinality of a relationship
- There are two types:
  - Mandatory
  - Optional

# Practice

- Your client is an online-education company. Could you help your client record the data needed?
  - The company has more than 100 instructors, more than 400 courses, 50 online programs, and around 1 million students.
  - Instructors:
  - Courses:
  - Programs:
  - Students:

# Practice

- Your client is an online-education company. Could you help your client record the data needed?
  - The company has more than 100 instructors, more than 400 courses, 50 online programs, and around 1 million students.
  - Instructors: instructorID, name, password, email, subject, phone, SSN, Bio, salary, rating,  programID,
  - Courses: courseID, TaughtBy, language, schedule, capacity, category, credit, programName, duration, description,
  - Programs: programID, programName, ProgramInfo, duration, CourseName, Price (Free), capacity, schedule.
  - Students: programID, email, studentID, DoB, StartDate, name, progress, phone, goal, payment()

# Practice

- You should first find Entities; what are they?
  - Instructors, Courses, Programs, Students.
- Then, what are the attributes of these entities?
  - Instructors have info: Name, *EmpID, SSN, DoB, Email, Salary.
  - Courses have info: Title, *Course#, Time, Location, Description.
  - Programs have info: *title, Chair, Office#, Contact, Description.
  - Students have info: Name, *StuID, DoB, Email.

# Practice

- Last, what are the relationships among these Entities?
  - An instructor may teach multiple courses, and multiple instructors might teach a course.
  - Each course must belong to only one online program, and each program must have one or more courses.
  - A student may take multiple courses, and a course must have one or more students.
  - A student must belong to exactly one program, and a program may have one or more students.
  - A student may be a friend of other students

# Next Lesson

01 Entity Relationship Model Representation

02 Chen notation

03 Crow's foot notation