

# Entities, Attributes, and Relationships

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  - Entity Types
  - Keys
  - Relationships



Let's Start a  
Business

# Start with Questions

- What is it? What does it do?
- What components do we need to track?
- What are the details?

# Entities and Attributes

- An entity is a collection, like a category, of data. For a business it usually means something worth tracking.
  - Physical
  - People
  - Results
  - Equipment
  - Resources
- Attributes are specifics about the entity
  - Names
  - ID's
  - Contact info
  - Material type
  - Amounts
  - Dates

# Design Tip

- Think about what is important to the business that is worth recording
- What details would you need to know to make each search possible?
- Think about how you would search for a specific record if you could just give an order with enough specifics:
  - “I need all of the people who work in our Chicago office”
  - “Let’s compare our sales to Europe from 2021 and 2022”
  - “Which of our products are affected by the 2022 COVID in China shutdown?”
  - “What day is our least profitable?”
  - “Which of our suppliers provides materials for this product?”
  - “How many delivery vehicles do we have, and who drives them?”

# **“Think of a Business Name”**

- What are its entities?

- Name 3 or 4 attributes of each entity

# How Do We Connect our Entities?

- If we separate the data too much, then we have no connections
- If we merge all of the data together, then our database is not very efficient
- Define relationships
  - How one entity connects to another



# Define Relationships

**Connect Two Entities**



**Relationship?**





# Modeling Our Data: Entity Relationship Diagrams (ERD's)

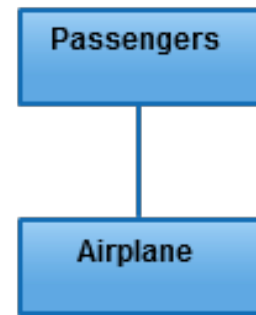
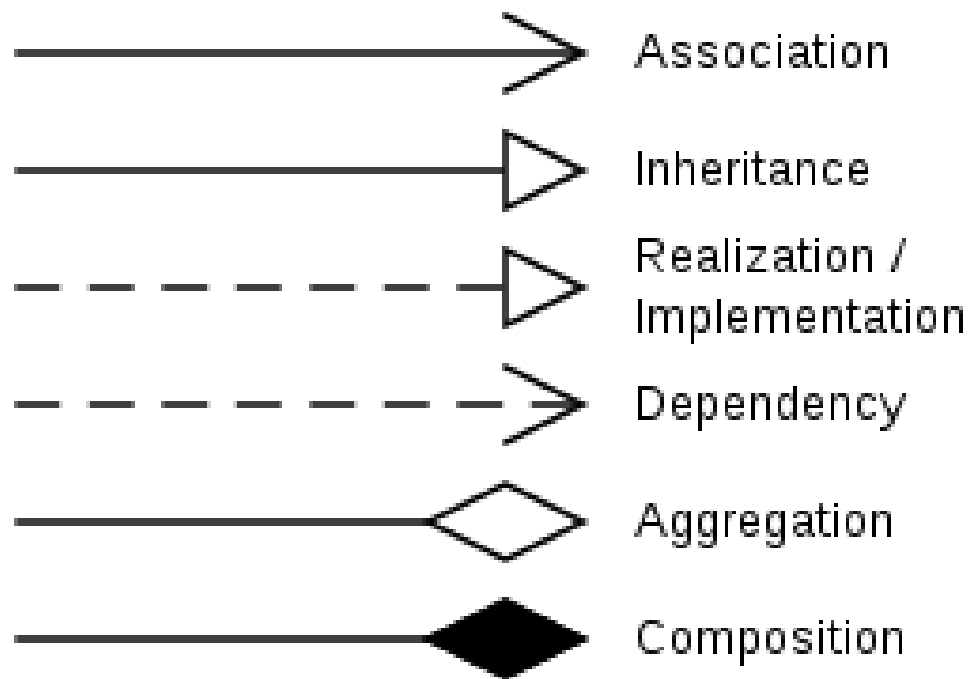
# Why Model?

- Planning
- Communicate our ideas to others
- Converts data into visible objects

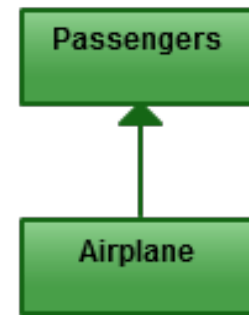
# Graphical depiction of ER Model

- An entity-relationship diagram (ERD) illustrates entity types, attributes, and relationships
- Three major types of ERDs
  - UML
  - Chen Model
  - Crow's Foot

# UML Example (Unified Modeling Language)



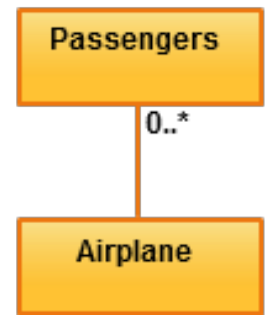
Association



Directed Association



Reflexive Association



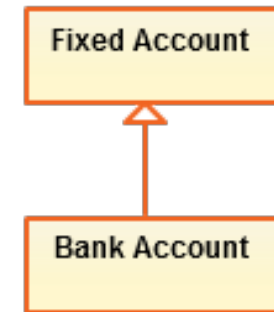
Multiplicity



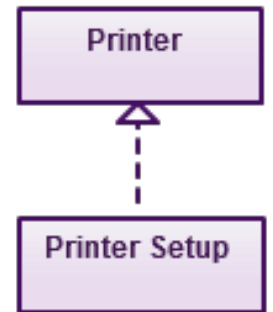
Aggregation



Composition

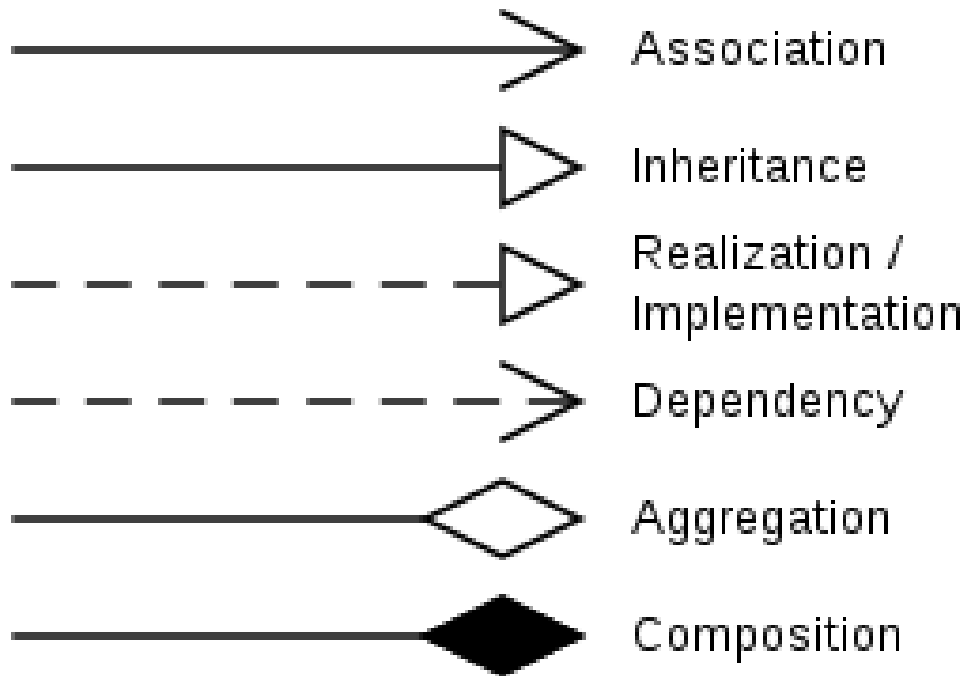


Inheritance



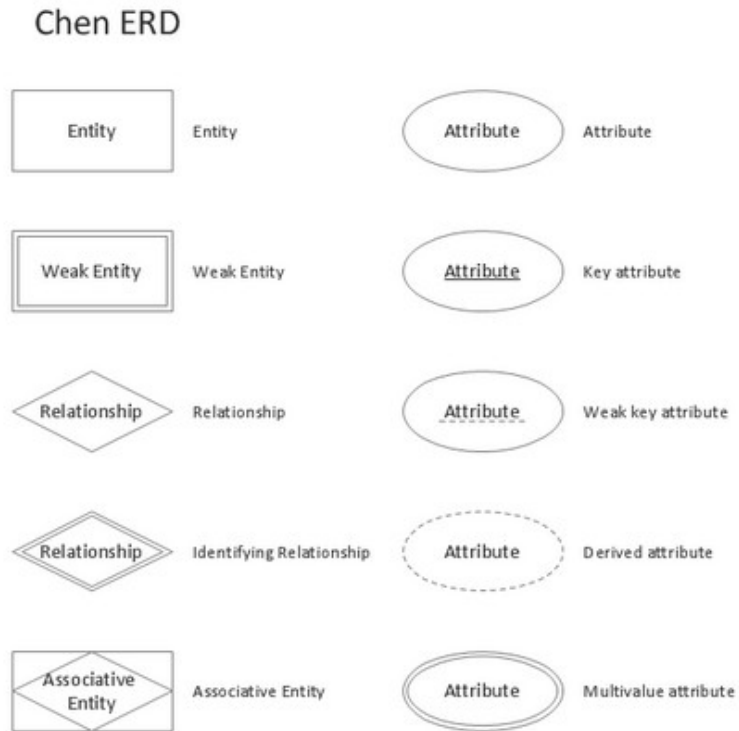
Realization

# UML Connections Explained



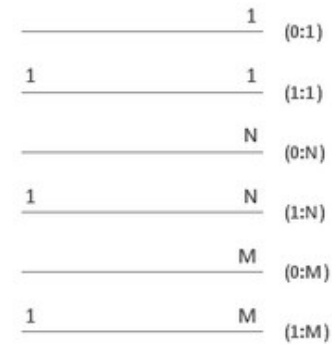
- Association - the two entities have a connection
- Inheritance - the dependent is a specific member of the determinant: tree and oak
- Realization - the determinant creates the dependent : tree and leaf
- Dependency - one entity needs the other
- Aggregation - the dependent is part of the determinant's collection, but can exist without it: classroom and student
- Composition - the dependent is part of the determinant and must coexist together: house and room

# Chen Model

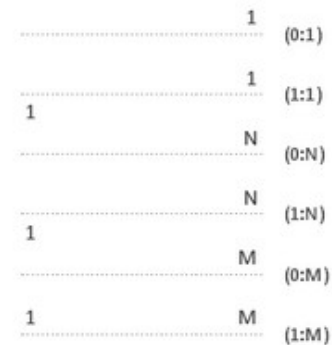


Participations  
Cardinality can be shown or hidden

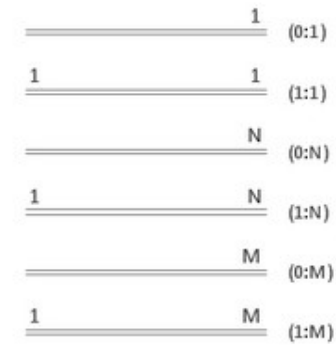
Mandatory



Optional

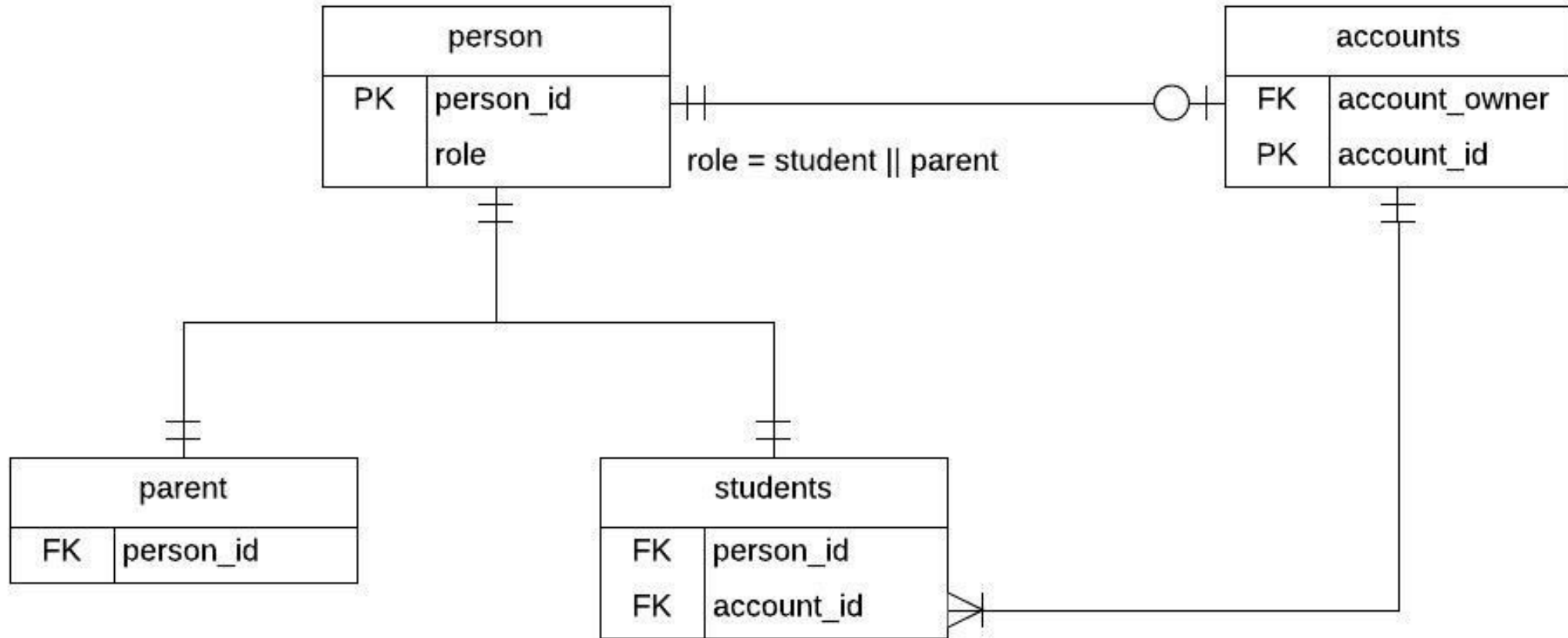


Recursive Relationship  
Cardinality can be shown or hidden



<https://www.conceptdraw.com/How-To-Guide/erd-diagrams-software-tools-for-design-element-chen>

# Crow's Foot Modeling





# Crow's Foot Connections

One



One to one relationship – ID#  
and Address

One (required)



One to one relationship – only  
one, and is required

Many



One to many relationship – ID#  
and courses enrolled

# Optional Connections

Zero or many



Optional – may not be any connections, or may be several – ID# and phone numbers

One or many



At least one connection but could be more – ID# and emergency contacts

# Summary

- A circle means that it's possible there are no relationships
  - Imagine a row where an entry could be blank
  - Would combine the circle with another symbol
- A vertical line means only one relationship is possible
  - Usually means one is a key
  - A double vertical means it's a unique relationship that cannot change
    - ID# and Social Security Number
- A three pronged fan means multiple relationships are possible
  - An entry in a row may be repeated in another row, such as a person belonging to more than one group, or a component that is used in more than one product
- Combine symbols to show multiple relationships are possible

# Step 1: Identify entity types

Objective: to identify the required entity types

# Entity Types

- Entity type represents a group of objects in the real world with the same properties
- A single occurrence of an entity type is an entity instance
- Entity names are singular nouns



# Determine primary key

- Objective: to identify the candidate key(s) for each entity and if there is more than one candidate key, to choose one to be the primary key and the others as alternate keys.
- The ideal primary key is short, numeric and never changes
- A surrogate or artificial key is primary key created by the database designer when no suitable single-column or composite primary key exists.
  - Usually artificial key values are integers, generated automatically by the database as new rows are inserted to the table.

# Strong and Weak Entity Types

- A strong entity does not depend on there being an associated entity from the related entity set
- A weak relationship exists between two strong entities
- A weak entity is existence-dependent on some other entity type
- For each strong entity create a relation that includes all the simple attributes of that entity.
- For each weak entity in the data model create a relation that includes all the simple attributes of that entity.
  - The primary key of a weak entity is partially or fully derived from each owner entity

- An entity's existence is dependent on the existence of the related entity
- Examples
  - Shopping cart item
  - Employee dependent
- To implement a dependent entity create a table to hold the dependent entity
  - A foreign key that references the master table primary key.
  - Another column that makes the composite primary key unique.

# Dependent entities



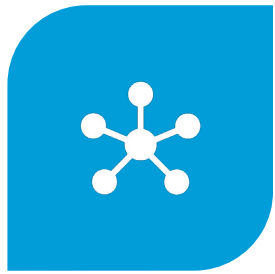
# Step 2: Identify relationship types

Objective: to identify the important relationships that exist between the entity types.

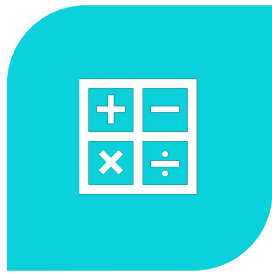
# Relationships

- Meaningful association among entities
- Participants are the entities involved
- Relationships are named as verbs using entity-verb-entity
- Visualize using ER diagrams

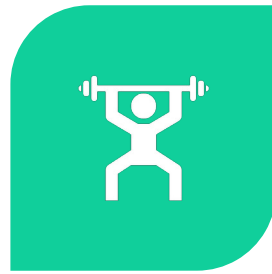
# Ways to describe relationships



CONNECTIVITY



CARDINALITY



STRENGTH



PARTICIPATION

# Connectivity

- One-to-one
- One-to-many
- Many-to-many

- For each one-to-many relationship, the entity on the 'one side' of the relationship is designated as the parent entity and the entity on the 'many side' is designated as the child entity.
- To represent this relationship, post a copy of the primary key attribute(s) of parent entity into the relation representing the child entity, to act as a foreign key.

## One-to-Many Relationship Types

# One-to-many Relationship

id	firstname	lastname	birthdate	rating	teamid
2	Julie	Zion	2000-08-08	B	1
3	Britta	Zarinsky	2001-09-09	B	7
4	Jenna	Koester	2001-12-26	B	5
5	Melissa	Kimble	2000-05-31	C	7
6	Jessica	Anderson	2001-03-16	A	3
7	Leslie	Ericson	2000-12-21	B	3
8	Jessica	Goodman	2000-03-16	A	1
9	Marci	Barber	2001-05-15	A	4
10	Nancy	Dorman	2001-12-12	A	2
11	Julie	Fraser	2000-04-04	C	4
12	Kelly	James	2002-07-01	A	3
13	Sherrie	Green	2000-08-22	A	4
14	Priscilla	Pearson	2002-02-03	B	3
15	Kerri	Stone	2000-04-04	C	5
16	Katie	Remmen	2002-04-18	A	1
17	Katherine	Akong	2000-02-02	C	NULL
18	Lilly	Taboas	2001-05-21	B	NULL
19	Jessica	Benjamin	2001-10-31	A	2

player

id	name	color
1	Rockets	Red/White
2	Comets	Blue/White
3	Bulldogs	Red/Black
4	Tar Heels	Orange/Green
5	Tornadoes	Blue/Gold
6	Eagles	Orange/Blue
7	Blue Devils	Maroon/Gold

team

# One-to-many Relationship

CustomerName	CustomerPhone	CustomerAddress	CustomerZip	InsuranceType	CoverageAmount	RenewalDate	AgentID
Alfred A. Ramas	815-544-2573	118 N. 80th Street, Romeoville, IL	60446	TI	100	4/5/15	A001
Leona K. Dunne	773894-1238	5409 Fire Pink way, Lisle, IL	60532	TI	250	6/16/15	A002
Kathy W. Smith	815-894-2205	6536 Poes Place., Romeoville, IL	60446	S2	150	1/29/15	A001
Paul F. Ostrowski	815-894-2180	4509 Parkgate Dr., Romeoville, IL	60446	SI	300	10/14/14	A001
Myron Oralndo	815-222-1672	P.O. Box 152, Frankfort, IL	60423	TI	100	12/26/14	A003
Amy B. O'Brien	773442-3381	2128 Holiday Dr., Lisle, IL	60532	T2	850	9/22/14	A003
James Q. Brown	815-297-1220	65 Bradford Walk, Frankfort, IL	60423	SI	120	3/25/15	A001
George Williams	815-290-2556	110 SW 12th st., Romeoville, IL	60446	SI	250	7/17/15	A003
Anne B. Fariss	815-382-7185	10420 S. Shepard Ave., Frankfort, IL	60423	T2	100	12/3/12	A002
Collete K. Smith	815-297-3609	645 N. Chestnut St., Romeoville, IL	60423	S2	500	3/14/15	A002

AgentID	AgentName	AgentPhone
A001	Leah F. Hahn	815-662-2144
A002	Alex B. Alby	773-228-1249
A003	John T. Olson	815-123-5589

- Cardinality cannot be used to identify the parent and child entities in a relationship.
- Instead, the participation constraints are used
  - mandatory participation on both sides of 1:1 relationship
  - mandatory participation on one side of 1:1 relationship
  - optional participation on both sides of 1:1 relationship

## One-to-One Relationship Types



- Create a new relation to represent the relationship
  - Intersection table or Entity Bridge Set
  - The new table names usually consists of the related table names
- Table contains
  - primary key attribute(s) of the entities that participate in the relationship, to act as foreign keys.
  - any attributes that are part of the relationship.
- The foreign keys will also form the primary key of the new relation
  - Composite key

## Many-to-many relationship types

# Many-to-many Relationsh

number	name	credits	teacherid
70-200-1	Introduction to CS	3	klumpra
70-200-2	Introduction to CS	3	klumpra
70-200-3	Introduction to CS	3	howardcy
70-200-4	Introduction to CS	3	howardcy
70-210-1	Programming Fundamentals	3	szczurpi
70-220-1	Introduction to UNIX	3	perryja
13-200-1	Calculus I	4	juracoma
13-310-1	Discrete Math	4	ayalada
13-240-1	Applied Calculus	4	koksalfa
70-330-1	Database	3	howardcy
13-130	Math Analysis	4	mascarra

id	name
411	Smith, Jonathan
412	Rucker, Daniel
413	Gonzalez, Sophie
414	Green, Emily

studentId	courseNumber
411	70-220-1
411	70-200-1
411	13-200-1
412	13-310-1
412	70-210-1
412	70-220-1
413	70-220-1
413	70-330-1
413	13-310-1
414	13-310-1
414	70-330-1
414	70-200-3

# Cardinality

- Number of entity instances associated with one occurrence of the related entity.
- No special notation for cardinality in the Crow's foot model

# Relationship Strength

- A strong entity does not depend on there being an associated entity from the related entity set
- A weak relationship exists between two strong entities
- A strong relationship exists between a strong and weak entity or two weak entities

# Participati on

- A relationship is mandatory to an entity if the entity must have a corresponding entity occurrence in a particular relationship
- A relationship is optional to an entity if the entity is not required to have a corresponding entity in the relationship

# Step 3: Identify and associate attributes

Objective: to associate attributes with the appropriate entity or relationship types and document the details of each attribute.

# Attributes

- Property of an entity
- Attributes are associated with a domain
  - Set of allowable values

- Create a new relation to represent multi-valued attribute and include primary key of entity in new relation, to act as a foreign key.
- The primary key of the new relation is the combination of the multi-valued attribute and the primary key of the entity.

Product	WarrantyOption
2.2L-eng	5yr
3.0L-eng	3yr   5yr
3.3L-eng	2yr   3yr   5yr
3.8L-eng	2yr   3yr   5yr

# Multi-valued Attributes