

CSIT115 Data Management and Security

Object Modeling

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Object Modeling

Outline

Graphical Notations for Conceptual Modeling

(Simplified) Class of Objects

Association

Link Attribute

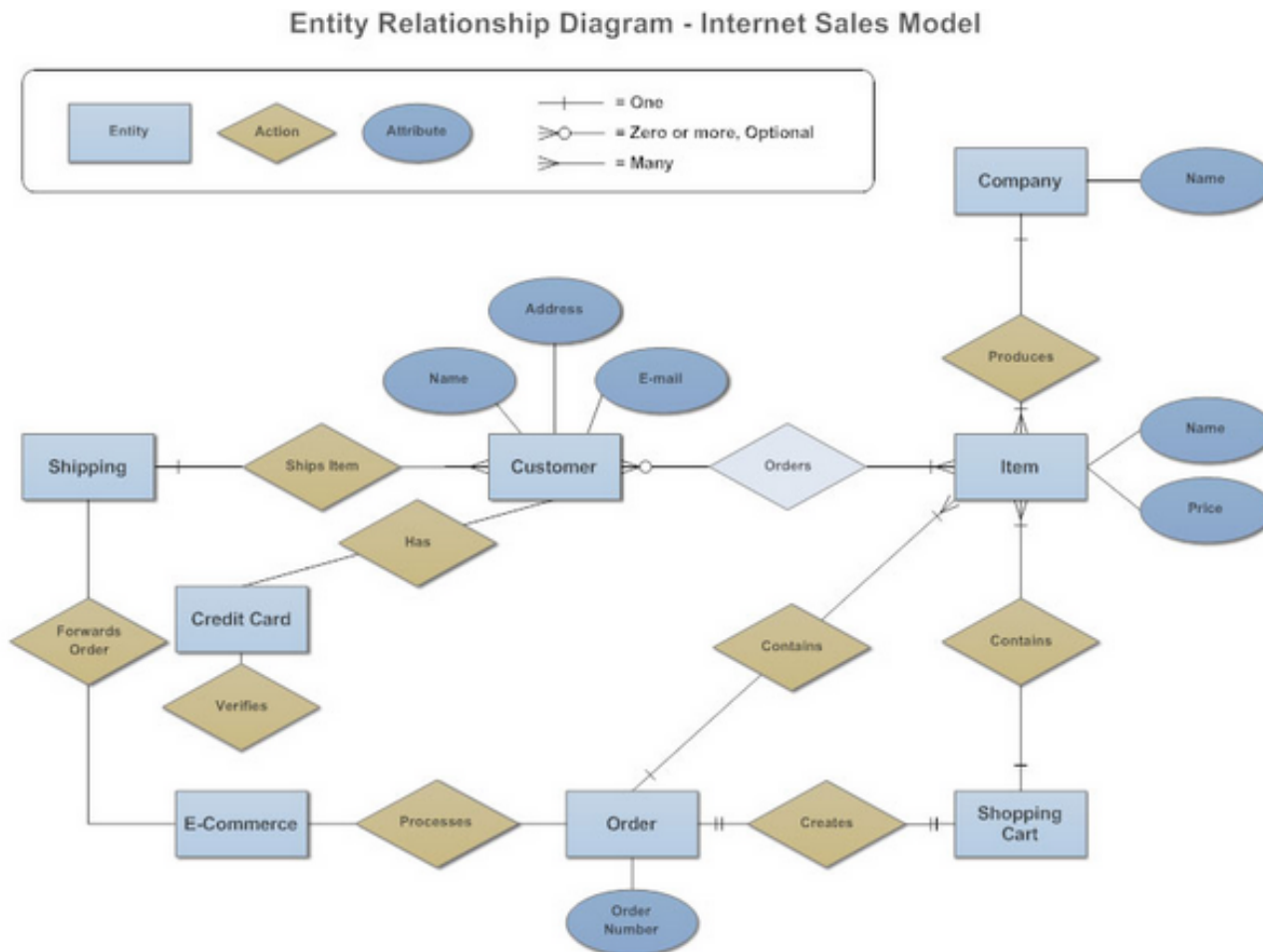
Association Class

Qualification

Generalization

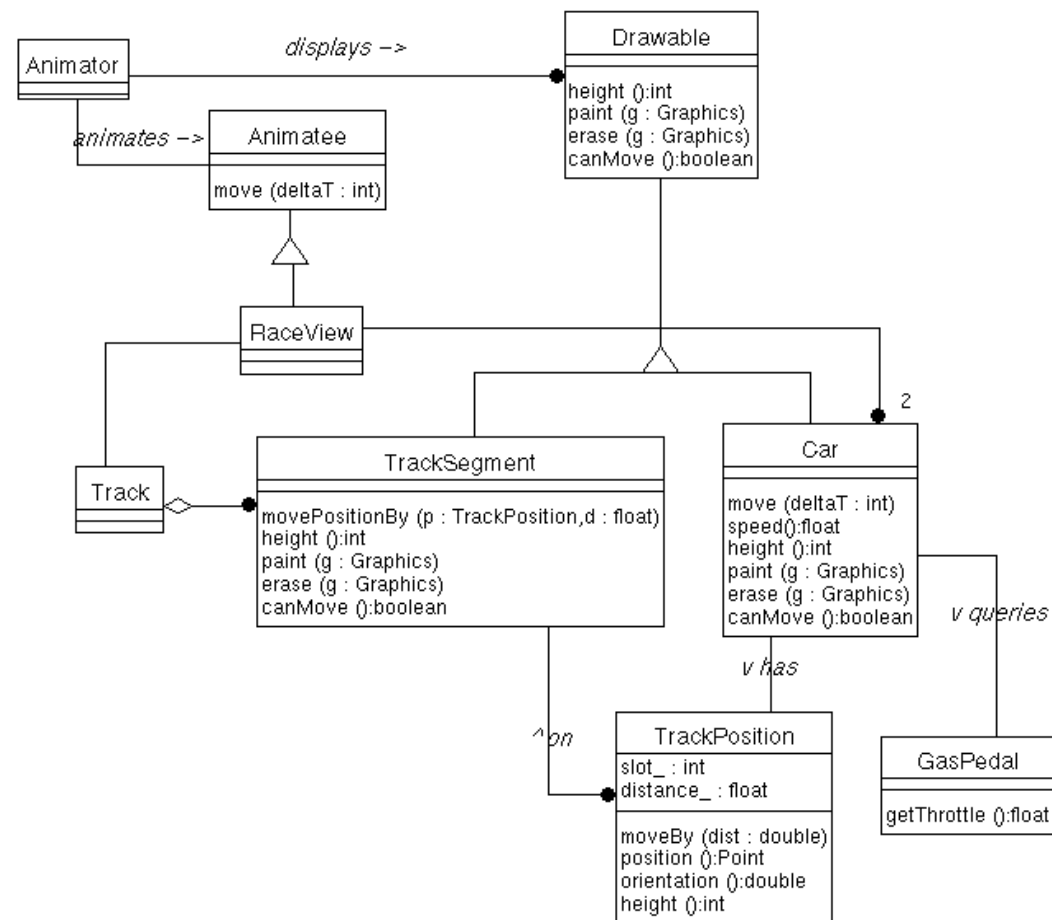
Graphical Notations for Conceptual Modeling

Entity-Relationship (ER) diagrams (1976)



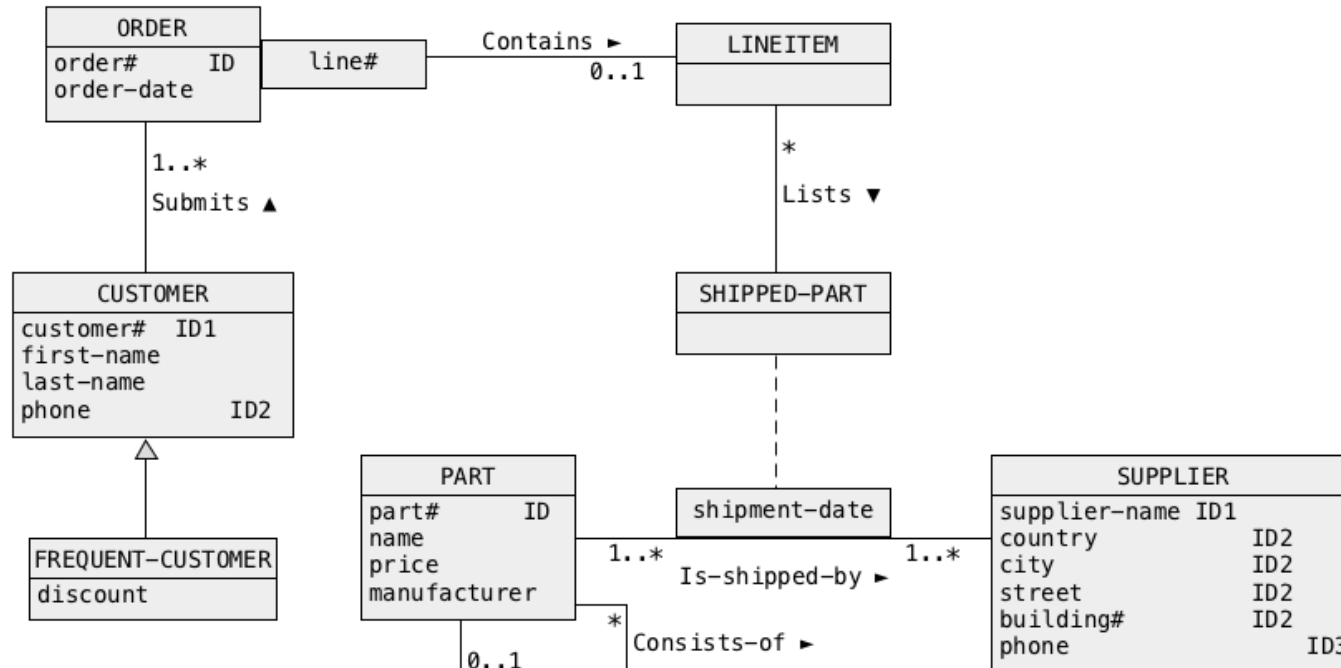
Graphical Notations for Conceptual Modeling

Object Modelling Technique (OMT) diagrams (1991)



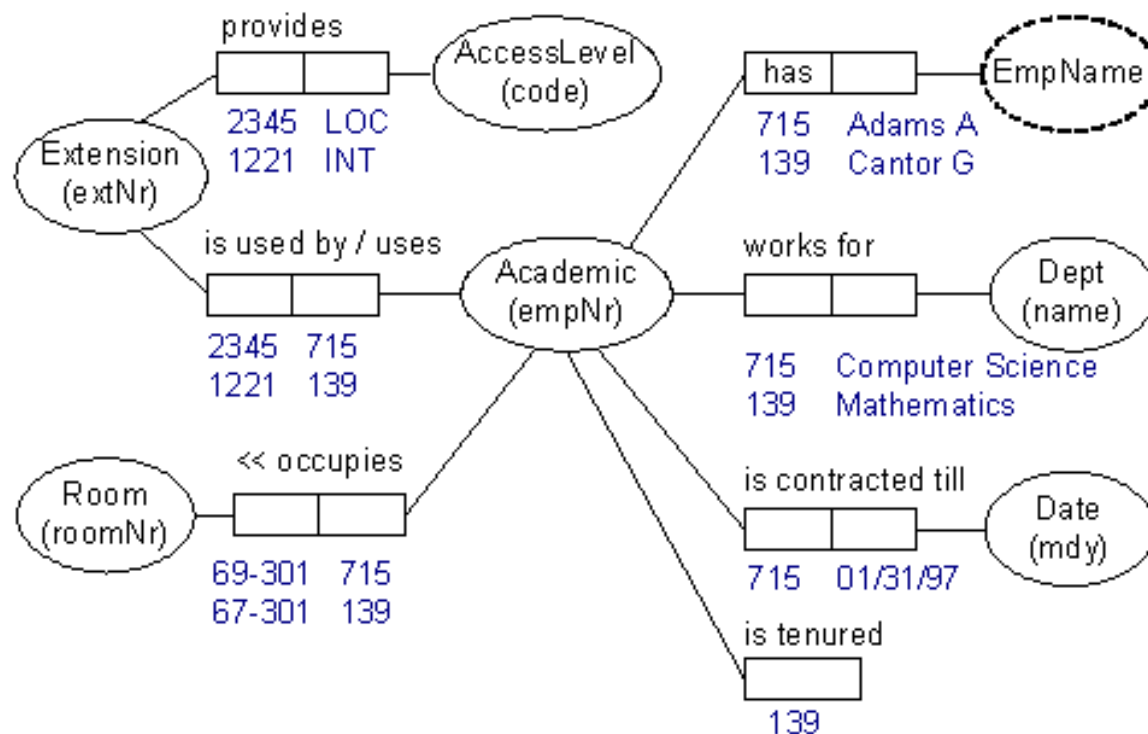
Graphical Notations for Conceptual Modeling

(Simplified) Unified Modelling Language (UML) Object Class diagrams
(1994)



Graphical Notations for Conceptual Modeling

Object Role Modeling (ORM) diagrams



... and many, many, ... other graphical notations

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(Simplified) Class of Objects

A database suppose to contain information about **people**

PERSON

A rectangular box with a header and a name of class (**PERSON**) inside a header represents a **(simplified) class of objects**

A **person** is described by a **social security number**, **name**, **date of birth**, and **address**

PERSON
ssno
name
dob
address

The names of attributes are listed within a rectangular box one name of attribute per row

(Simplified) Class of Objects

A **person** has from one to five **email addresses** and zero or more **phone numbers**

PERSON
ssno
name
dob
address
email[1..5]
phone[*]

Multiplicity of attribute like [1..5] (from one to five), zero or more ([*] or [0..*]), one or more ([1..*]), optional (zero or one, [0..1]), from "m" to "n" ([m..n]) follows a name of attribute

Default **multiplicity** is "one" ([1])

(Simplified) Class of Objects

A **person** is described by an optional country of origin and age (/ in front of attribute name **age** denotes a **derived attribute**)

PERSON
ssno
name
dob
address
email[1..5]
phone[*]
contry[0..1]
/age

(Simplified) Class of Objects

A **person** is identified by a **social security number** and independently by a triple (**name**, **date of birth**, **address**)

PERSON	
ssno	ID1
name	ID2
dob	ID2
address	ID2
email[1..5]	
phone[*]	
contry[0..1]	
/age	

A tag **ID_x** following a name of attribute means that an attribute is an **identifier**

If the same tag (e.g. **ID₂**) follows the names of several attributes then it means that an **identifier** consists of several attributes

If an **identifier** consists of several attributes then it means that each object in a class is identified by a **tuple of values** of the attributes

An **identifier** which consists of several attributes is called as a **composite identifier**

(Simplified) Class of Objects

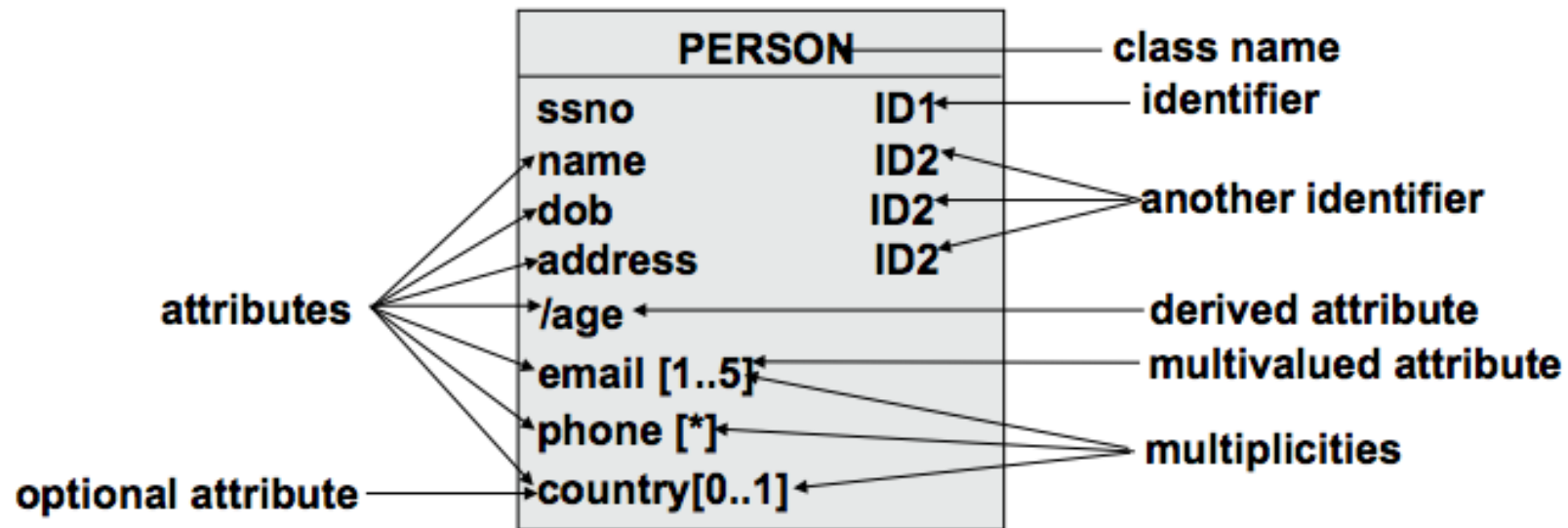
A **vehicle** is described by a registration number, manufacturer, model, year when manufactured, and optional fuel consumption

Each **vehicle** has a different registration number

VEHICLE	
rego#	ID1
manufacturer	
model	
year	
fuel[0..1]	

(Simplified) Class of Objects

Summary



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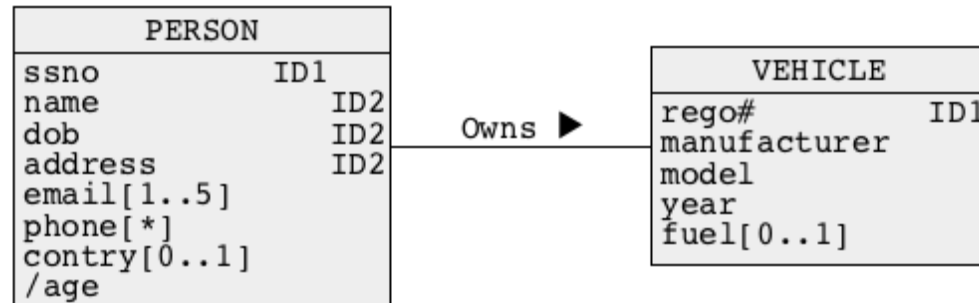
Association Class

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Association

A person owns a vehicle



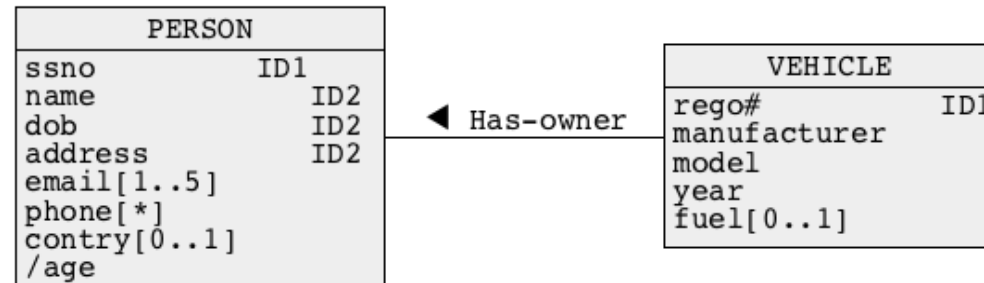
A solid line that connects two classes represents an **association**

A name above a line is an **association name**

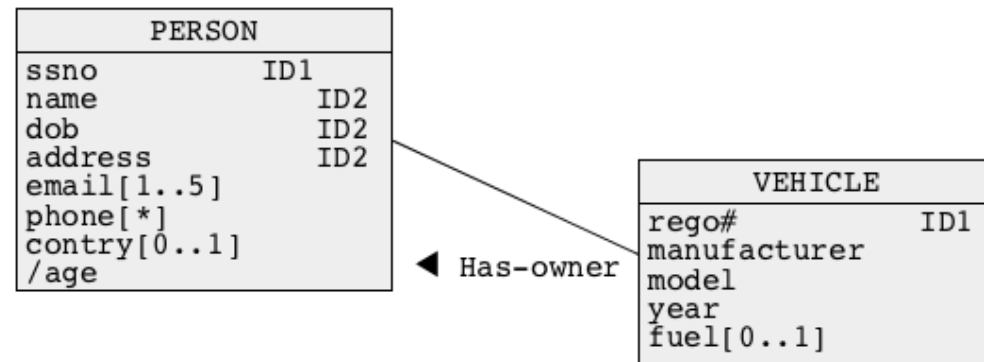
An **association name** if followed (preceded or located above or below) by a small solid triangle that represents a **direction of interpretation** of an association

Association

A vehicle **has** an owner

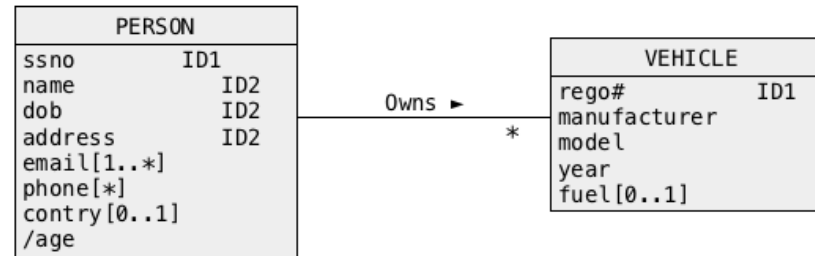


Locations of classes and associations in a diagram are immaterial

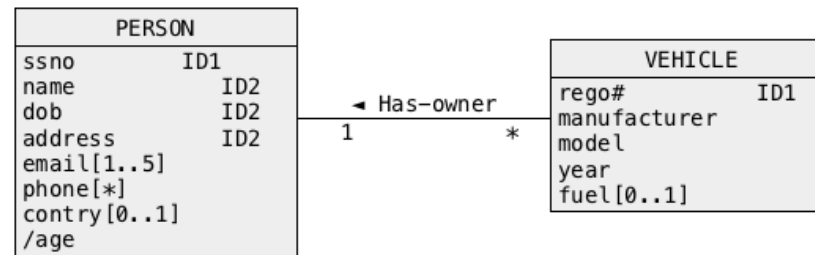


Association

A person owns zero or more vehicles



A vehicle has one owner

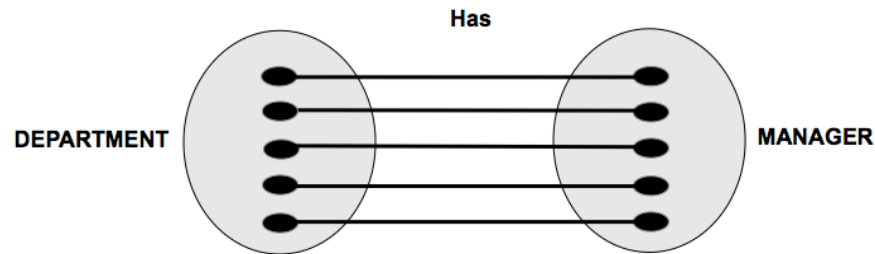
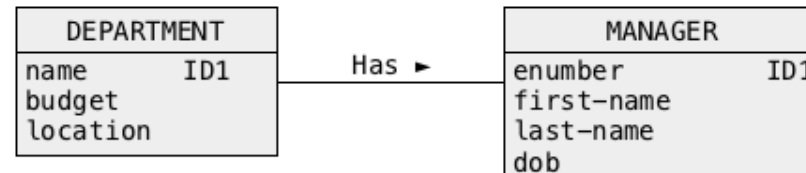


Multiplicities of association are located at both ends of a line that represents an association

Association

One-to-one association

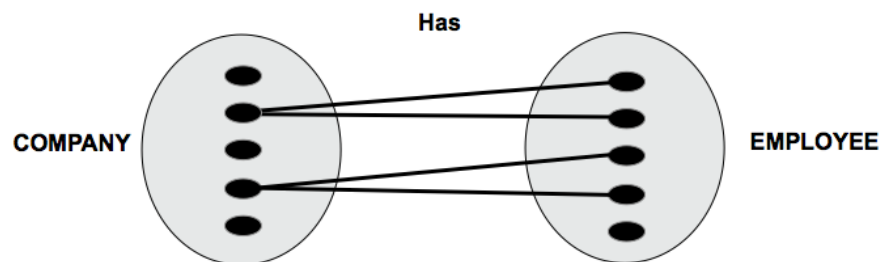
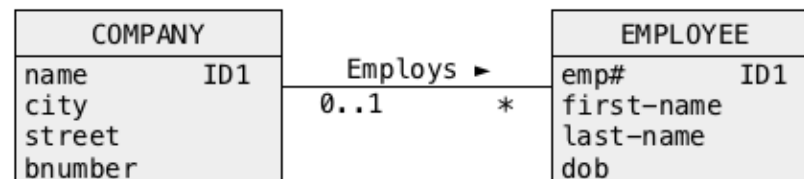
- A department **has** a manager
- A department has exactly **one** manager
- A person who is a manager manages exactly **one** department



Association

One-to-many association

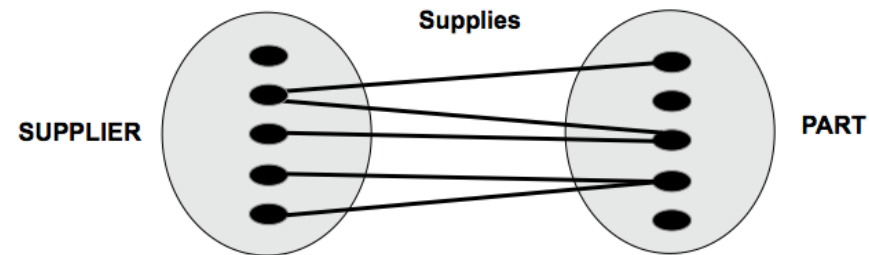
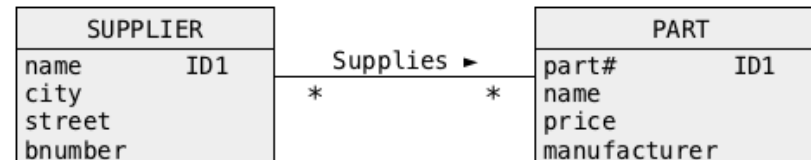
- A company **employs** an employee
- A company employs **many** employees
- An employee works for **none or one** company
- It is possible that a company has **no (zero)** employees



Association

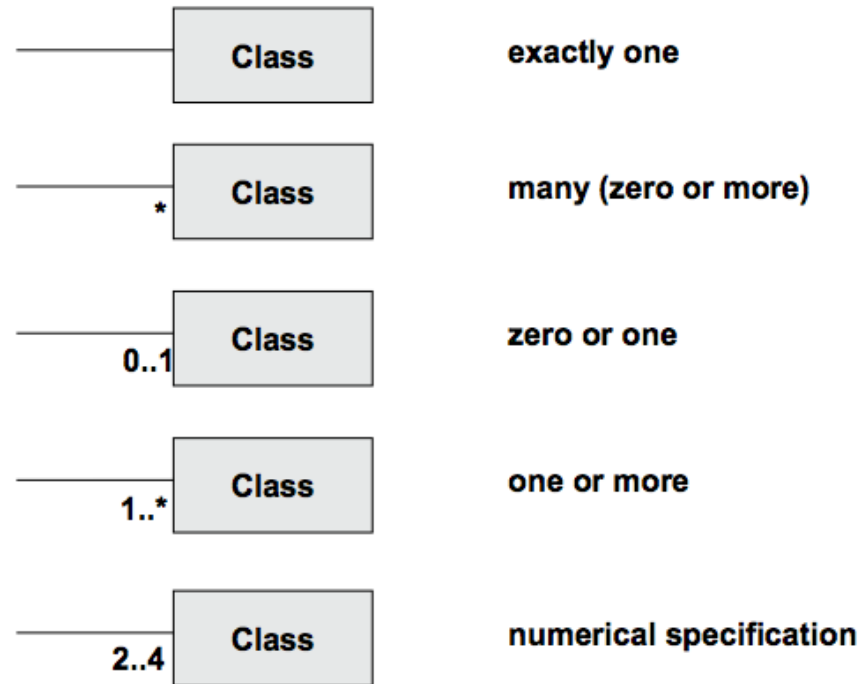
Many-to-many association

- A supplier **supplies** a part
- A supplier supplies **zero or more** parts
- A part is supplied by **zero or more** suppliers



Association

Summary

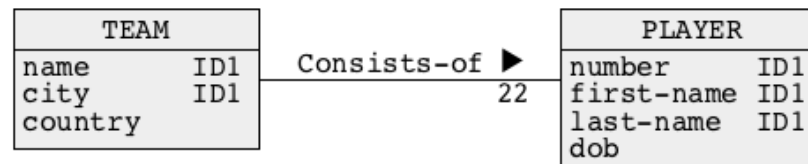


Association

More examples:

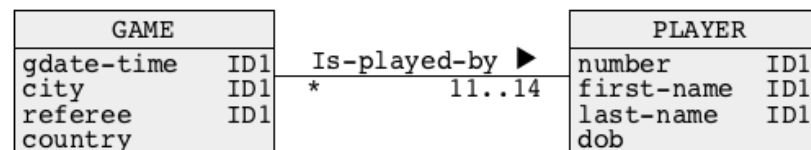
A team consists of **22** players

A player belongs to only **one** team



A game is played by **11** players plus maximum **3** substitutes

A player participates in **zero or more** games



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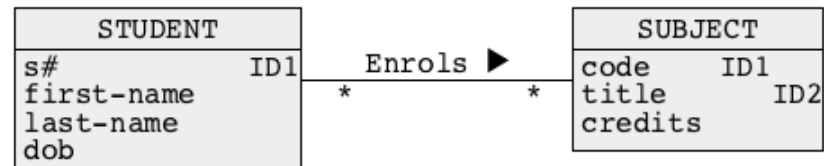
Qualification

Generalization

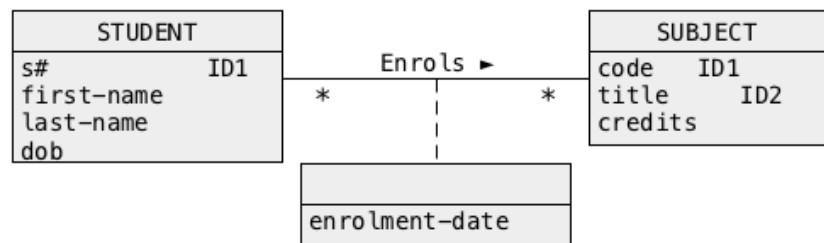
Link Attribute

A **link attribute** is an attribute that describes an **association**

A **student enrolls** a **subject**



An enrolment is performed on a given day, i.e. an enrolment is described by an **enrolment date**



A **link attribute** is graphically represented by a "class-like" rectangular box without a name of class in a header

Link Attribute

Why an attribute `enrolment-date` must be represented by a **link attribute** ?

For example, what about an attribute `enrolment-date` describing a class `STUDENT` ?

STUDENT	
s#	ID1
first-name	
last-name	
dob	
enrolment-date[*]	

Such design **is incorrect** because information about which subject has been enrolled on what date by a student is missing

A student is associated with a set of `enrolment-dates`, however ...

... there is no link between the values of an attribute `enrolment-date` and the objects in a class `SUBJECT`

Link Attribute

So what about another option, an attribute `enrolment-date` describes a class `SUBJECT` ?

SUBJECT	
code	ID1
title	ID2
credits	
enrolment-date[*]	

Such design **is also incorrect** because information about who enrolled a subject on what date is missing

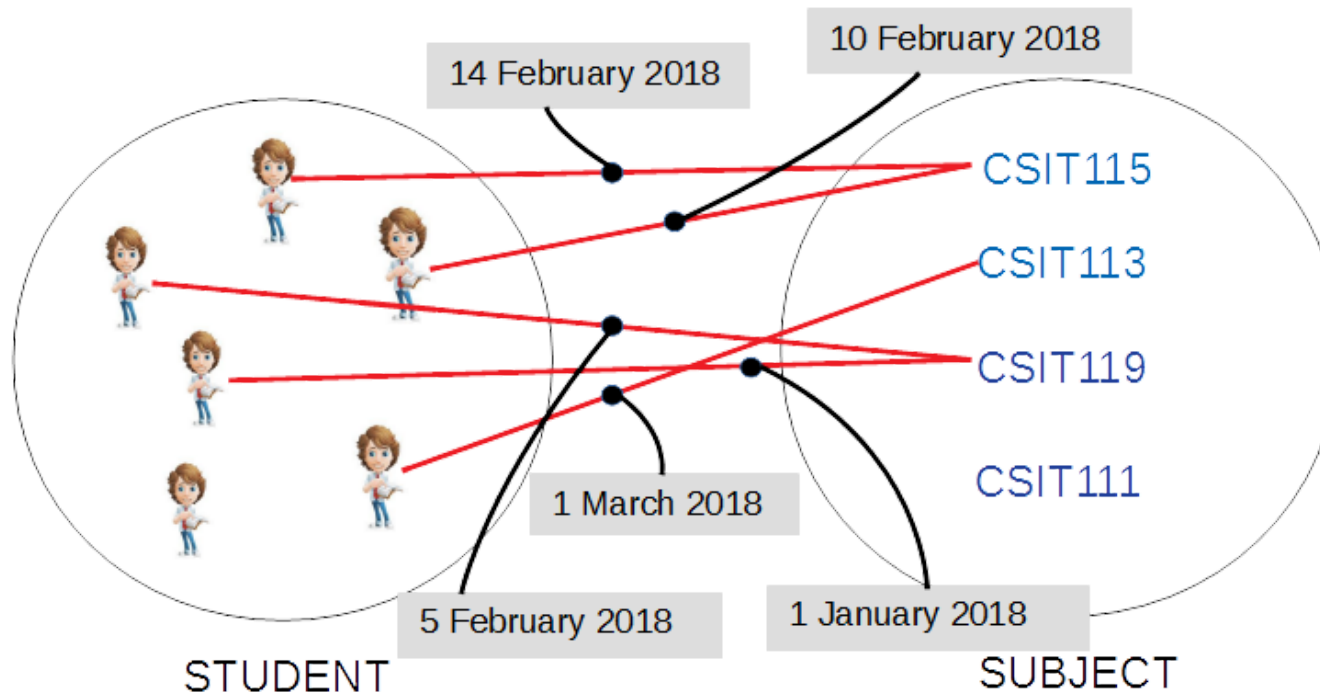
A subject is associated with a set of `enrolment-dates`, however ...

... there is no link between the values of an attribute `enrolment-date` and the objects in a class `STUDENT`

Therefore, the only option for an attribute `enrolment-date` is to be a **link attribute**

Link Attribute

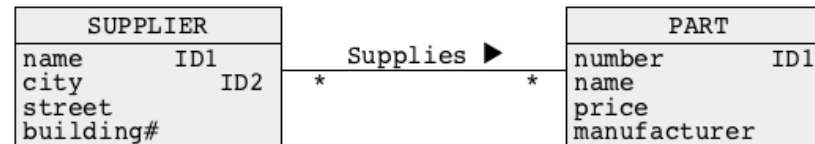
It is correct because an attribute `enrolment-date` describes an association between the classes `STUDENT` and `SUBJECT`, i.e. the pairs of objects from the classes `STUDENT` and `SUBJECT`



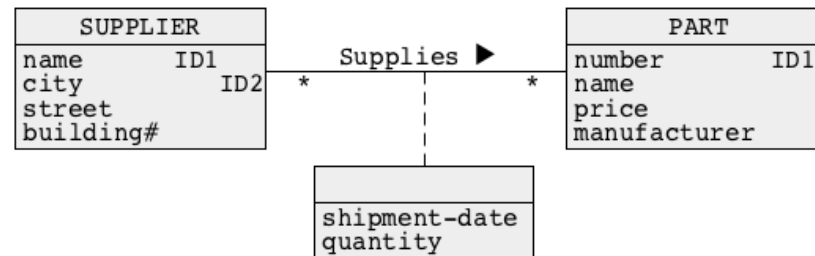
Link Attribute

Another example of **link attribute**

A **supplier** **supplies** a **part**



A shipment of a part is performed on a given day, i.e. a shipment is described by an attribute **shipment date** and a shipment contains a given number of parts, i.e. a shipment is also described by an attribute **quantity**



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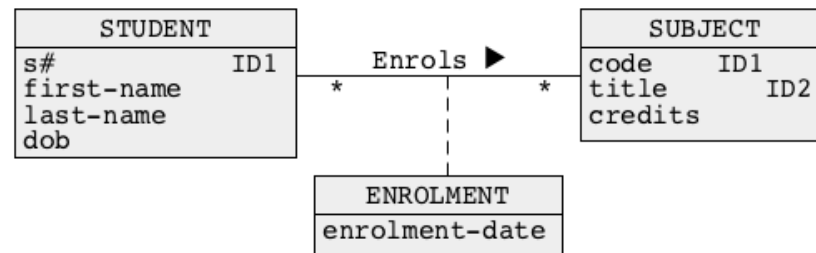
Association Class

An **association class** is a class that represents an **association**

A **student** **enrols** a **subject**



An enrolment is performed on a given day, i.e. an enrolment is described by an attribute **enrolment-date**



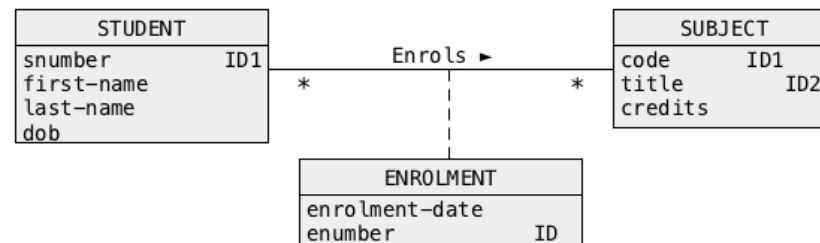
An **association class** **ENROLMENT** is graphically represented in the same way as a class of objects

Association Class

What about an **identifier** of an **association class** ?

An **association class** may have its own identifiers, e.g. `enrolment-number` in a class `ENROLMENT`

An **association class** that represents many-to-many association has a **default identifier** that consists of identifiers of the classes from both sides of association, e.g. (`snumber`, `code`) in a class `ENROLMENT`



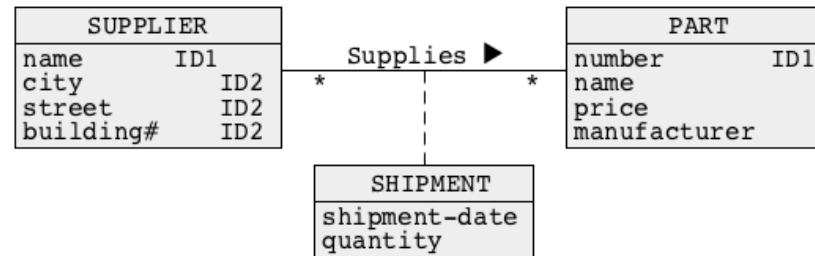
There is no need to include a **default identifier** into a description of a class of objects

Association Class

Another example of **association class**

A **supplier** **supplies** a **part**

A shipment of a part is performed on a given day, i.e. a shipment is described by an attribute **shipment-date** and a shipment contains a given number of parts, i.e. a shipment is also described by an attribute **quantity**

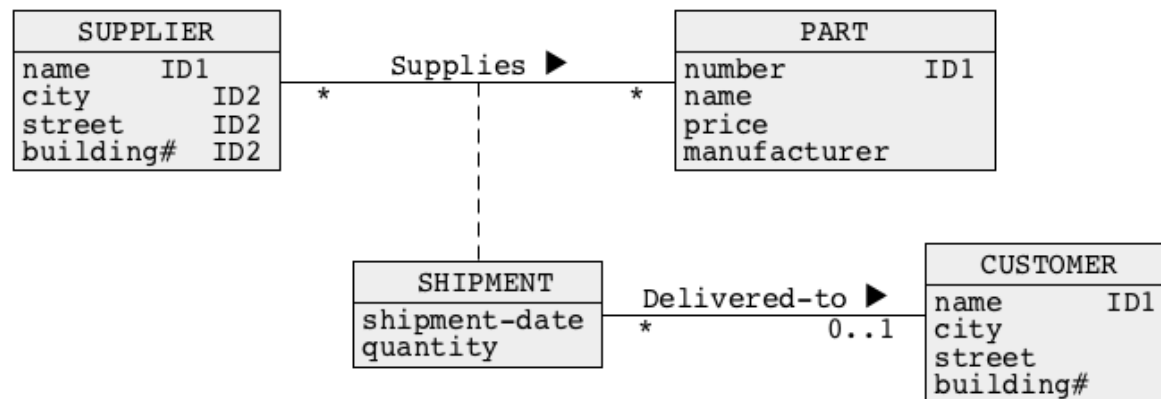


Association Class

What can we use **association classes** for ?

A **shipment** is **delivered to** a **customer**

An association **Delivered-to** connects the classes **SHIPMENT** and **CUSTOMER**



In a general case, it is possible to create associations between association classes and other classes of objects and between association classes and association classes

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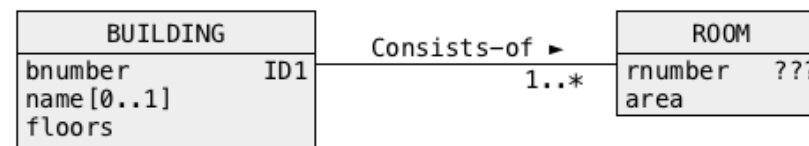
Generalization

Qualification

A **building** at a university campus is described by a unique **number**, optional **name** and the **total number of floors**

A **room** is described by a **number** and **area**

A **building** consists of **rooms**



What is an identifier of a class **ROOM** ?

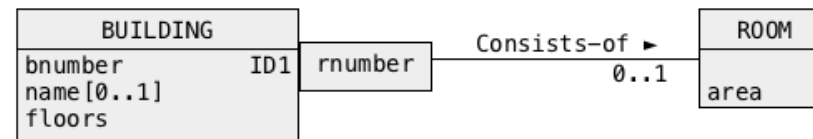
Identifier of a class **ROOM** is a **composite identifier** and it consists of the attributes **bnumber** from a class **BUILDING** and **rnumber** from a class **ROOM**

How do we represent composite identifiers that consist of attributes from more than one class ?

We use a **qualification** !

Qualification

A **building** at a university campus is described by a unique **number**, optional **name** and the **total number of floors**. A **room** is described by a **number** and **area**. A **building** consists of **rooms**



A **qualification** is represented by a rectangle with one or more attribute names

In the example above a **qualification** means that in a given **building** there is at most one **room** with a given **number**

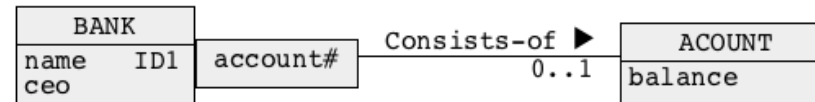
It also means that an attribute **rnumber** is a **local identifier** in a class **ROOM**, i.e. all **rooms** in a given **building** have different **numbers**

A pair of attributes (**bnumber**, **rnumber**) is a **default identifier** of a class **ROOM**

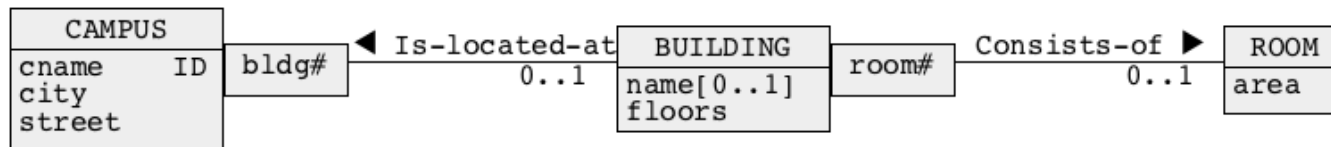
Qualification

More examples:

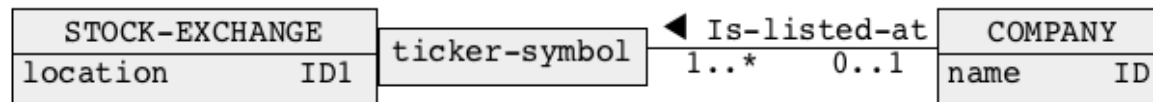
A bank account is located at a bank



A campus consists of buildings and buildings consist of rooms



A company is listed at stock exchange

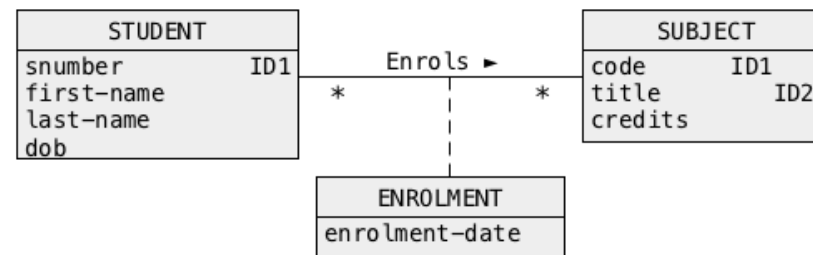


Qualification

Sometimes qualification is needed for **many-to-many** associations

For example, if consider a pessimistic view of **students** who **enrol subjects** then sometimes a student must enrol the same subject more than one time (well, ... you know when it happens and why it is a "pessimistic" view of the reality)

The original design created few slides ago was the following



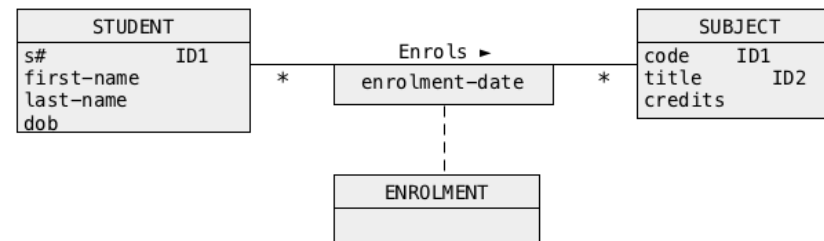
But, ... if enrolment is repeated several times than a pair of attributes(`snumber`,`code`) is no longer an identifier of a class `ENROLMENT` !

Qualification

If enrolment is repeated several time then an identifier of a class `ENROLMENT` is a triple (`snumber`,`code`,`enrolment-date`)

How such fact is represented graphically ?

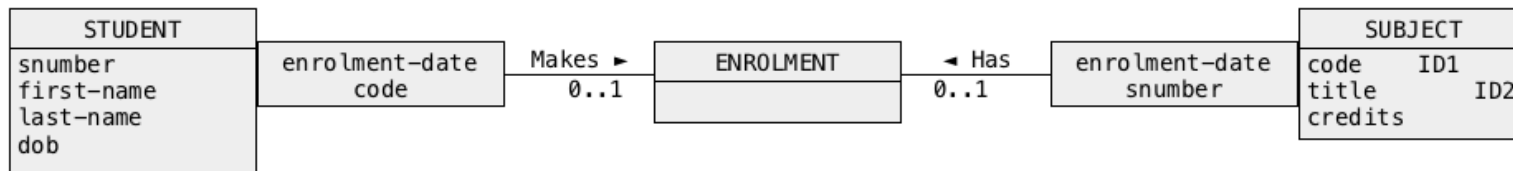
It is represented by a **qualification** of the middle part of association `Enrols` in the following way



Qualification of the middle part of many-to-many association means that identifier of an **association class** consists of an identifier of a class on the left hand side of association, identifier of a class on the right hand side of association, and qualification attribute(s)

Qualification

A qualification of the middle part of many-to-many-association is equivalent to the following two single-side qualifications of one-to-many association and many-to-one association



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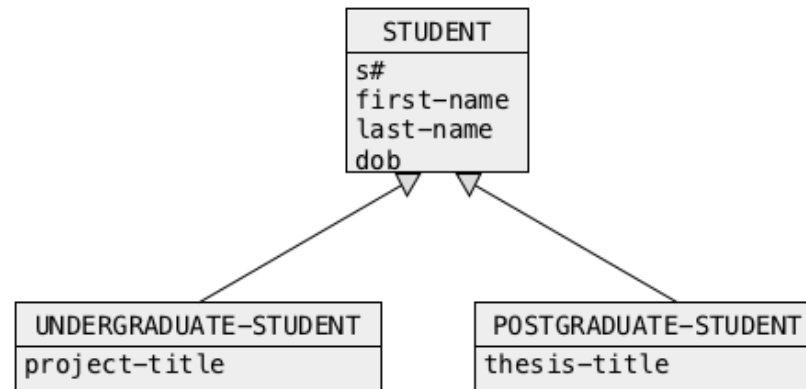
Generalization

Generalization

A **generalization hierarchy** represents **Is-a-subset** relation between the classes of objects

A set of all undergraduate students is a subset of a set of students, i.e. an undergraduate student **IS-A** student

A set of all postgraduate students is a subset of a set of students, i.e. a postgraduate student student

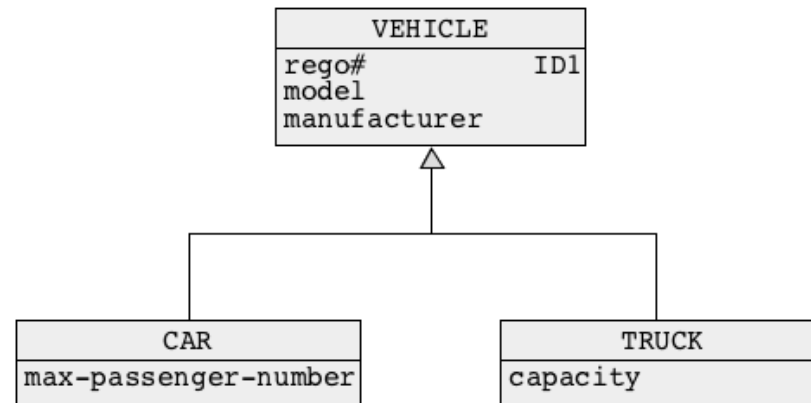


A **generalization hierarchy** is built with arrows pointing from a **subclass** to a **superclass**

Generalization

Another graphical notation for **generalization hierarchy**:

A car **IS-A** vehicle and a truck **IS-A** vehicle



To create a nice effect the arrows can be "joined" into a single arrow

Entity-Relationship Modeling

Entity-Relationship Modeling is another graphical conceptual modeling notation

It is presented in your textbook

Graphically it is very similar to Object Modeling

The following concepts from the notations are equivalent:

- Class of objects = Entity type
- Object = Entity instance
- Association = Relationship
- Identifier = Primary key or Candidate key
- Qualification = Weak entity type

References

T. Connolly, C. Begg, Database Systems, A Practical Approach to Design, Implementation, and Management, Chapter 12 Entity-Relationship Modeling, Chapter 13.1 Specialization/Generalization, Pearson Education Ltd, 2015