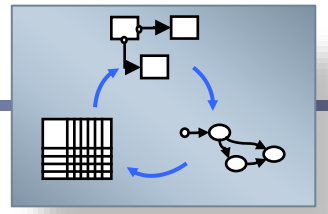
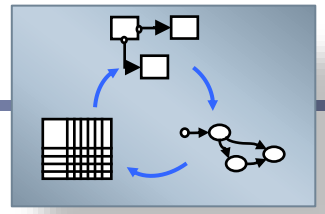


Boeing

This is an exercise from the Merode course at KU Leuven.

The solution is given as an EDG (part of a Merode model) and as a UML class diagram

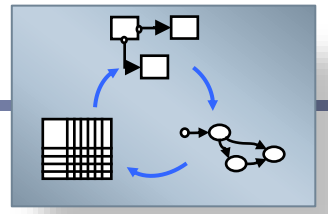
Some of the mistakes from student solutions are specific to Merode, others are universal



Boeing

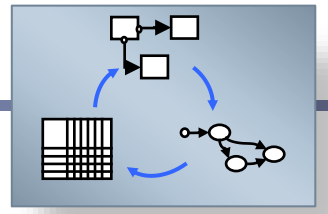
Boeing sells aircrafts to airline companies. As aircrafts are very expensive to build, they are only built "on demand", meaning that first a sales agreement is made with a customer, before the airplane is actually built. (An exception are demo versions of airplanes, but these are out of scope for this case). The sales are regulated by means of contracts with the airline companies, whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the negotiated price for that airplane, chosen options, delivery date, etc. Each contract is managed by a Boeing salesperson. An employee can act as salesperson for several contracts. Given the long term of contracts, the assigned salesperson may change over time, but Boeing ensures there is always a salesperson available for the client.

Some airlines are related to each other: for example, main airlines often have a low cost daughter airline company. Such related airlines often share airplanes or sell their airplanes to their partners. As Boeing has different discount policies per airline, Boeing would like to avoid selling aircrafts at a high discount to one airline company, and then see this aircraft ending up at a partner airline that cannot benefit from the same large discount. Boeing therefore keep track as much as possible of the mother-daughter relationships between airline companies, to be able to track whether to sold aircrafts are shifted to partner airlines of the original buyer.



Boeing

Development of model-solution



Boeing

Boeing sells aircrafts to airline companies. These sales are regulated by means of contracts with the airline companies, whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the chosen model of airplane, the negotiated price for that airplane, chosen options and customizations, delivery date, etc.

Boeing

- Universe of discourse, not a business object

Contract

- The central business object type

Airline

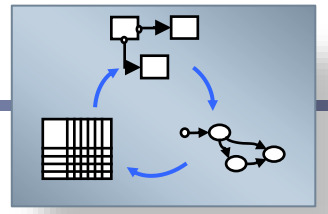
- The receiving party of the contract

Aircraft

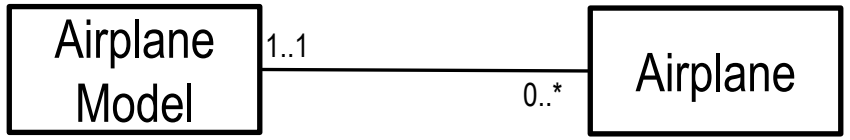
- The subject of the contract

Aircraft Model

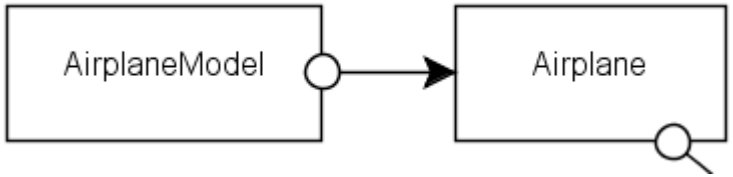
- The model according to which the aircraft will be built



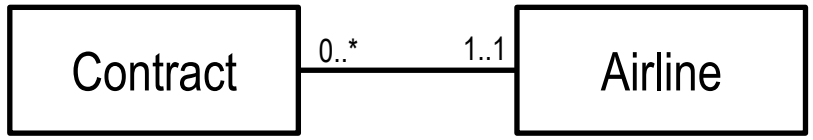
- the chosen model of the airplane ...
- Many airplaines can be built according to a given model, and each airplane is built according to exactly one model.



- Once an airplane is built according to a model, this can never change.
  - Here we clearly have a case of existence dependency



Boeing UML to EDG



Boeing sells aircrafts to airline companies. These sales are regulated by means of contracts with the airline companies, ...

The cardinalities are not fully clear from the specifications, so further investigation is required.

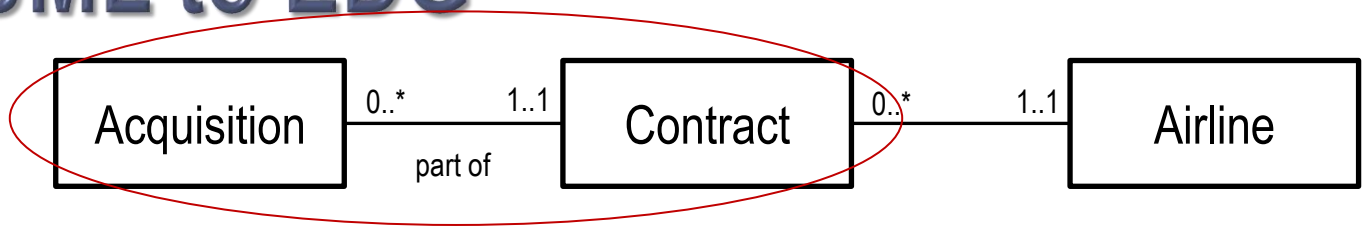
Questions:

- Does a contract need an airline right from the start? Yes. It's highly unlikely to have a contract without a partner.
- Can a contract have more than one Airline: probably not.

- So the cardinality of the association end on the side of the Airline is 1..1
  - Investigate Existence Dependency: Can the airline of a contract be changed? No.

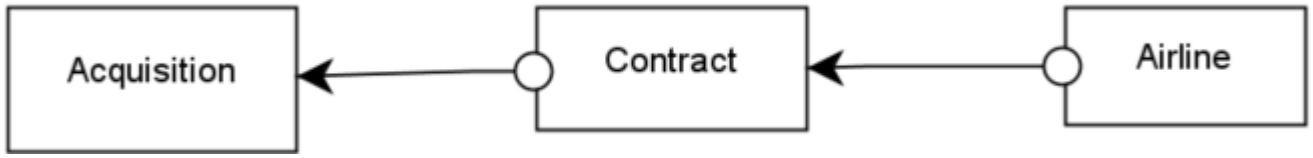
→ 1..1 + not modifiable means that it expresses existence dependency. No association reification will be required.

Boeing UML to EDG

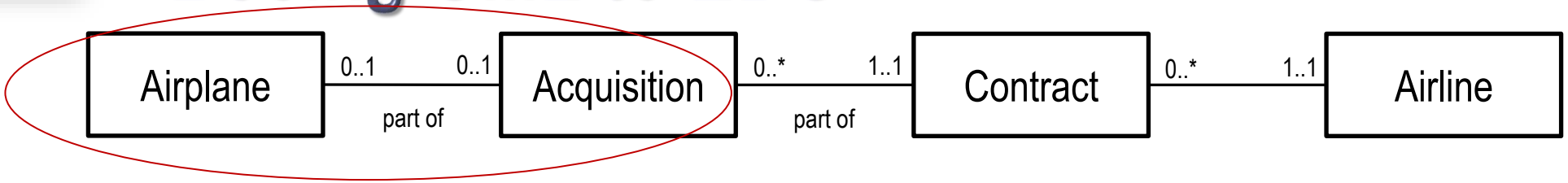


... whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the negotiated price for that airplane, chosen options, delivery date, etc.

An acquisition is a part of a contract. In this case, the "part_of" relation expresses existence dependency: an acquisition will not be moved from one contract to another



Boeing UML to EDG



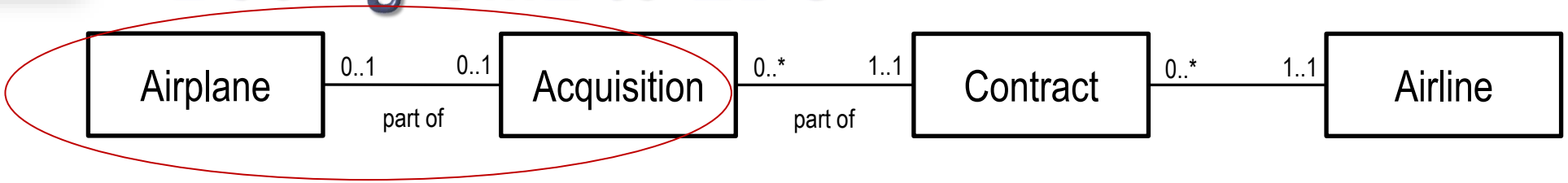
... whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the negotiated price for that airplane, chosen options, delivery date, etc.

Assumptions:

1) Aircraft is a specific unique aircraft, not a type of aircraft of which several instances are built.

2) While negotiating the acquisition, initially no airplane might be defined yet.

Boeing UML to EDG

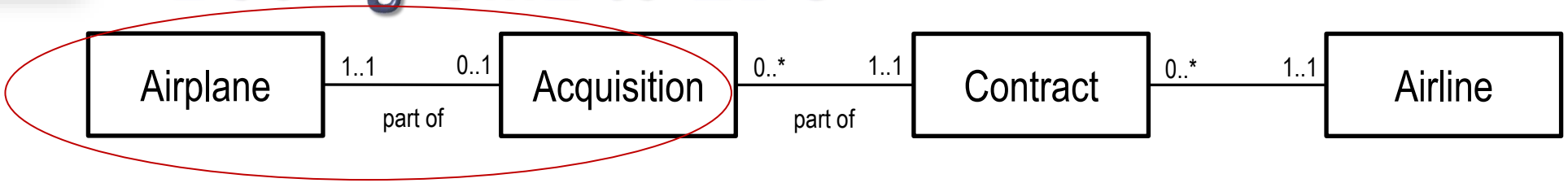


... whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the negotiated price for that airplane, chosen options, delivery date, etc.

Question: What exists first: the Acquisition or the Airplane ?This is not clear:

- If Boeing builds aircrafts after the contract has been signed (build-to-order), then the acquisition exists first, and an airplane cannot exist without acquisition.
- If Boeing builds aircrafts first and then tries to sell them (build-to-stock), then the airplane exists first
- Can the contract of an aircraft be changed?
  - Build to stock ➔Yes. Contract might be cancelled, and then aircraft will be sold to another airline.
  - Build to order ➔Standard would be no. But if a contract is cancelled while the airplane is in construction, then Boeing will probably try to sell it to another airline. This means we are back in a build-to-stock-like situation.

Boeing UML to EDG



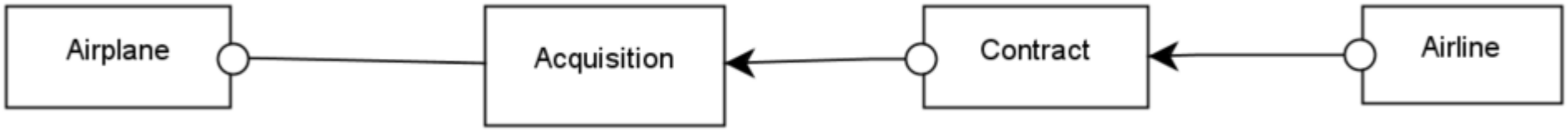
... whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the negotiated price for that airplane, chosen options, delivery date, etc.

Option 1A: Build to stock

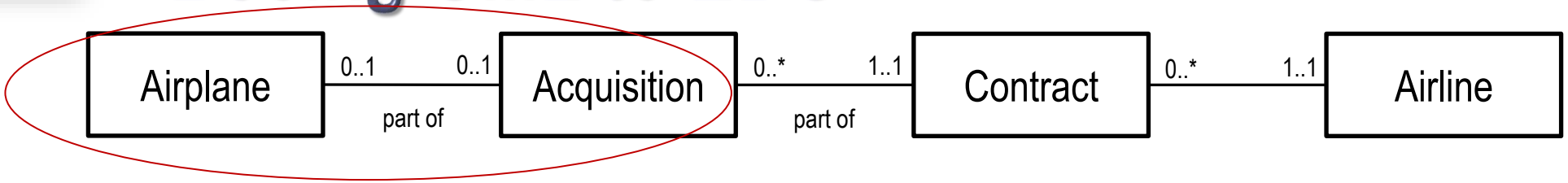
Acquisition existence dependent on Airplane. Implications of this model:

1) the airplane has to be know right from the start.

2) the airplane defined in the acquisition cannot be changed. If a change is needed, the existing acquisition is cancelled and a new one is created for the other airplane.



Boeing UML to EDG



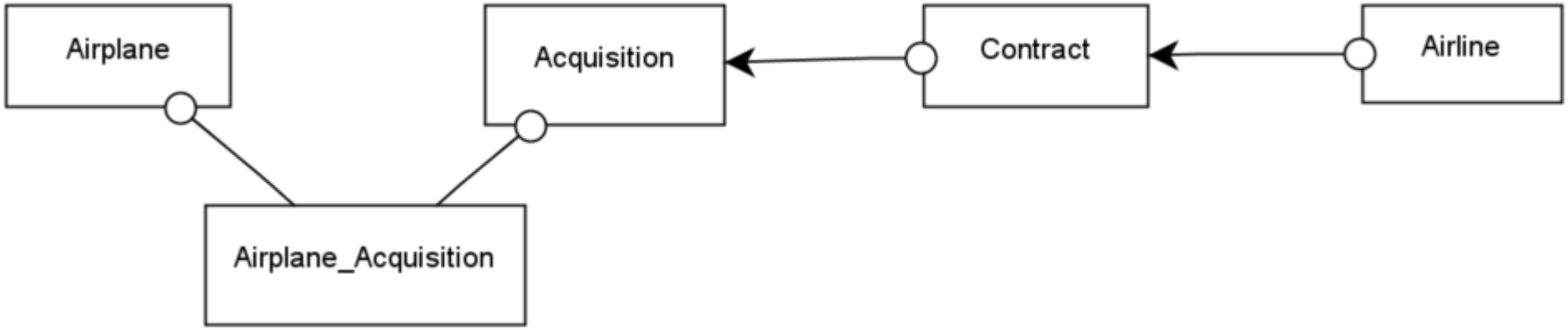
... whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the negotiated price for that airplane, chosen options, delivery date, etc.

Option 1B: Build to stock

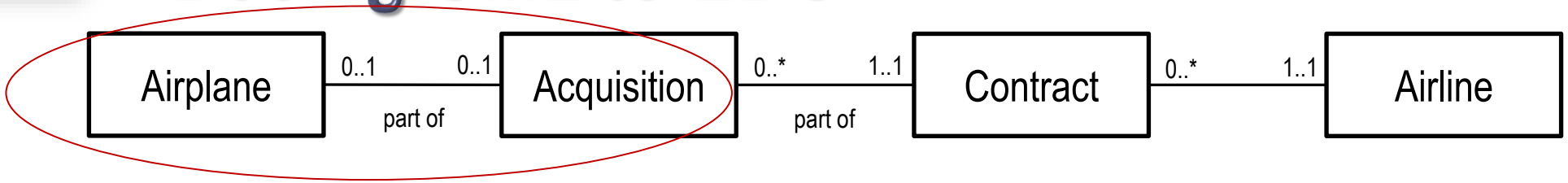
Acquisition NOT existence dependent on Airplane ==> reification. Implications of this model:

1) the airplane has NOT to be known right from the start, but can be chosen during negotiation process.

2) the airplane defined in the acquisition can be changed.



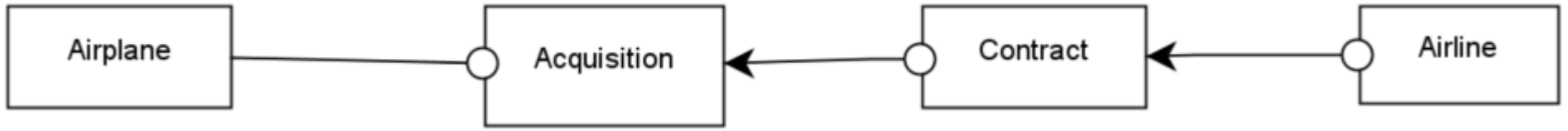
Boeing UML to EDG



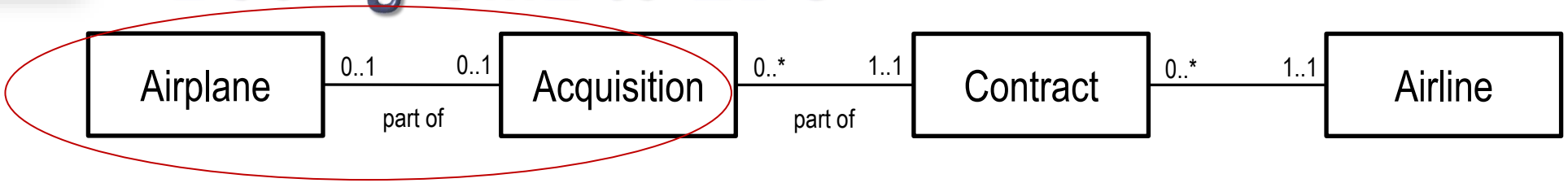
... whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the negotiated price for that airplane, chosen options, delivery date, etc.

Option 2A: Build to order ➔ Acquisition exists first, then Airplane.

- If Airplane is existence dependent on Acquisition, then if the acquisition is cancelled (=ended), the airplane object will have to be ended as well.



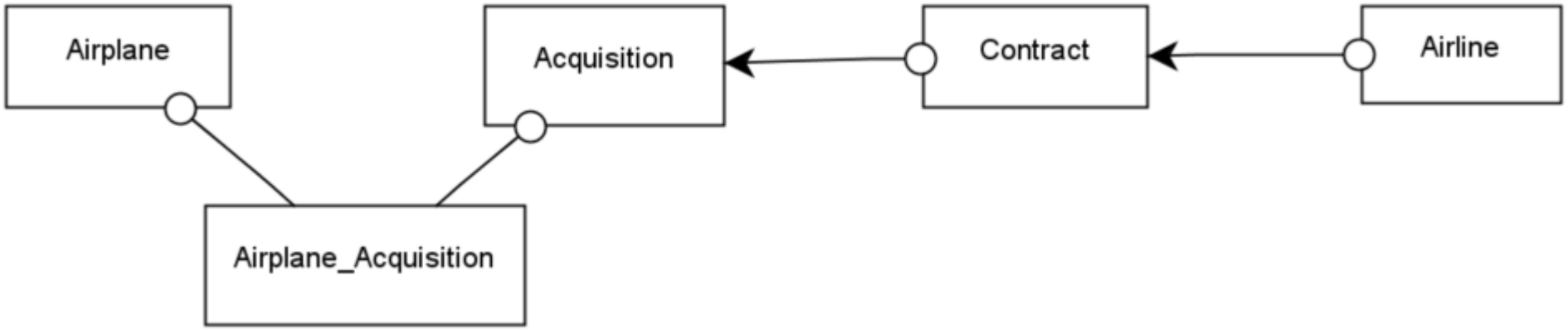
Boeing UML to EDG



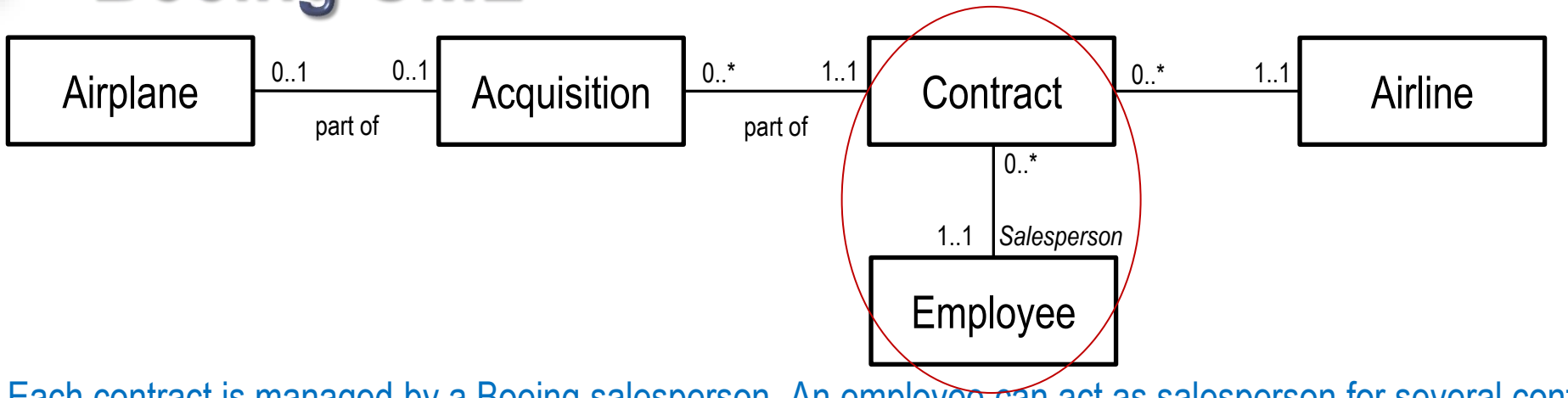
... whereby a single contract may consist of several acquisitions of airplanes. The global contract stipulates common elements across all acquisitions such as delivery conditions, legal aspects, etc. Each acquisition of an airplane has further specific details, such as the negotiated price for that airplane, chosen options, delivery date, etc.

Option 2B: Build to order ➔ Acquisition exists first, then Airplane.

- If Airplane can exist longer than a cancelled acquisition, there is no existence dependency ➔ reification is required



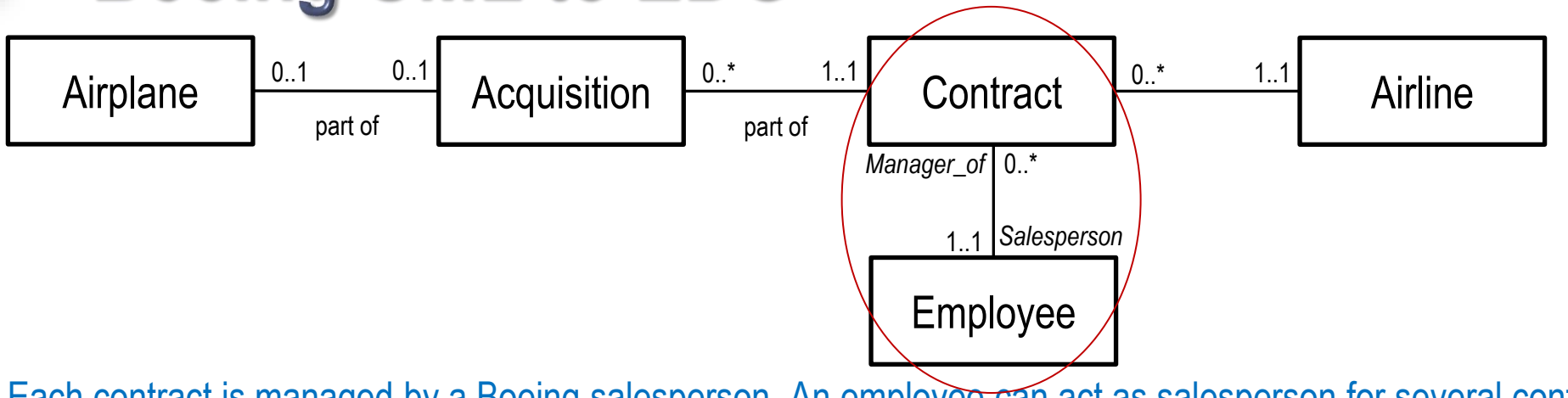
Boeing UML



Each contract is managed by a Boeing salesperson. An employee can act as salesperson for several contracts. Given the long term of contracts, the assigned salesperson may change over time, but Boeing ensures there is always a salesperson available for the client.

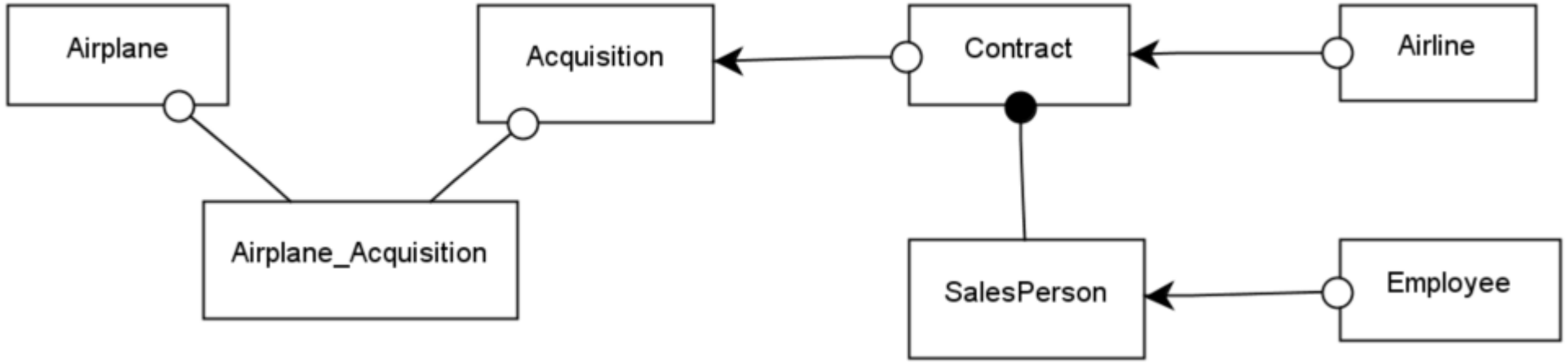
- Note that the description states “Boeing ensures that there is always a salesperson available for the client”
  - This means that a contract should have *at least* one salesperson
- Does a contract need a salesperson right from the start? Yes
- Can the salesperson of a contract be changed? Yes ⇒ not existent dependent – needs reification
- Note that salesperson is a (temporary) **role** of an employee: an employee *can act as* salesperson. So it is employee that is the business object type, not salesperson.

Boeing UML to EDG

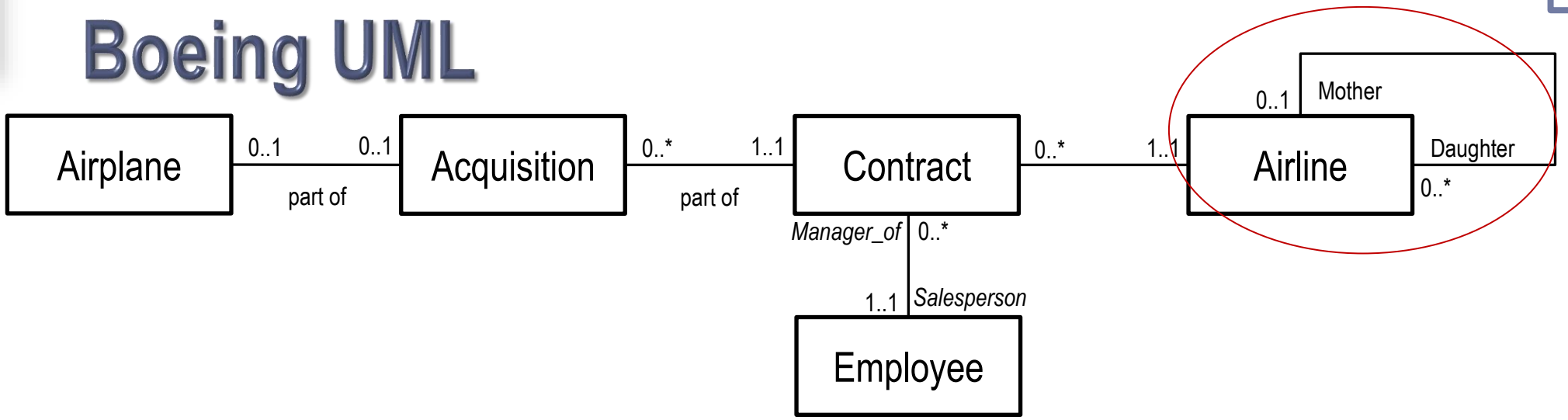


Each contract is managed by a Boeing salesperson. An employee can act as salesperson for several contracts. Given the long term of contracts, the assigned salesperson may change over time, but Boeing ensures there is always a salesperson available for the client.

- not existent dependent – needs reification



Boeing UML

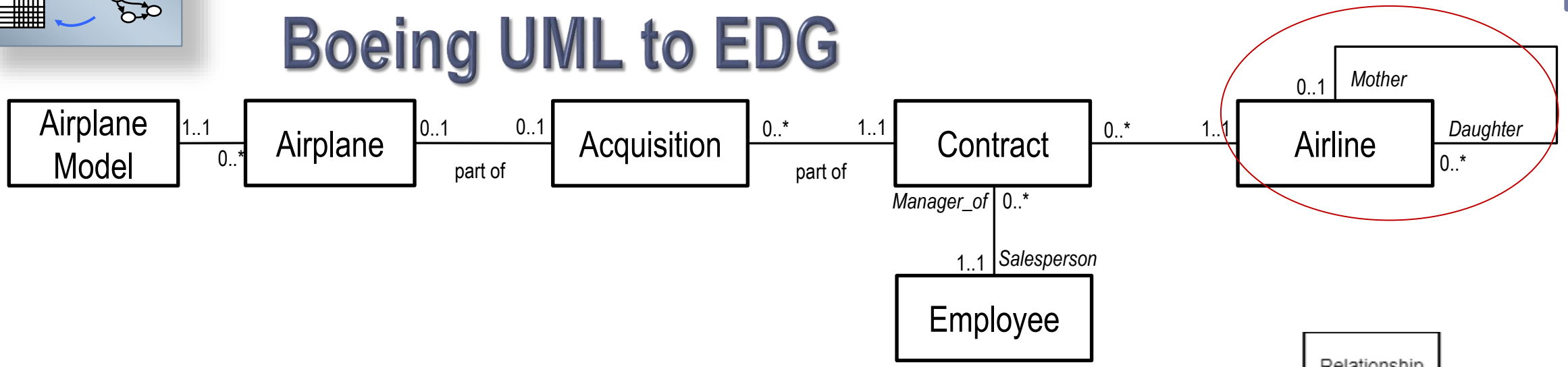


Some airlines are related to each other: for example, main airlines often have a low cost daughter airline company. Boeing therefore keep track as much as possible of the mother-daughter relationships between airline companies, to be able to track whether to sold aircrafts are shifted to partner airlines of the original buyer.

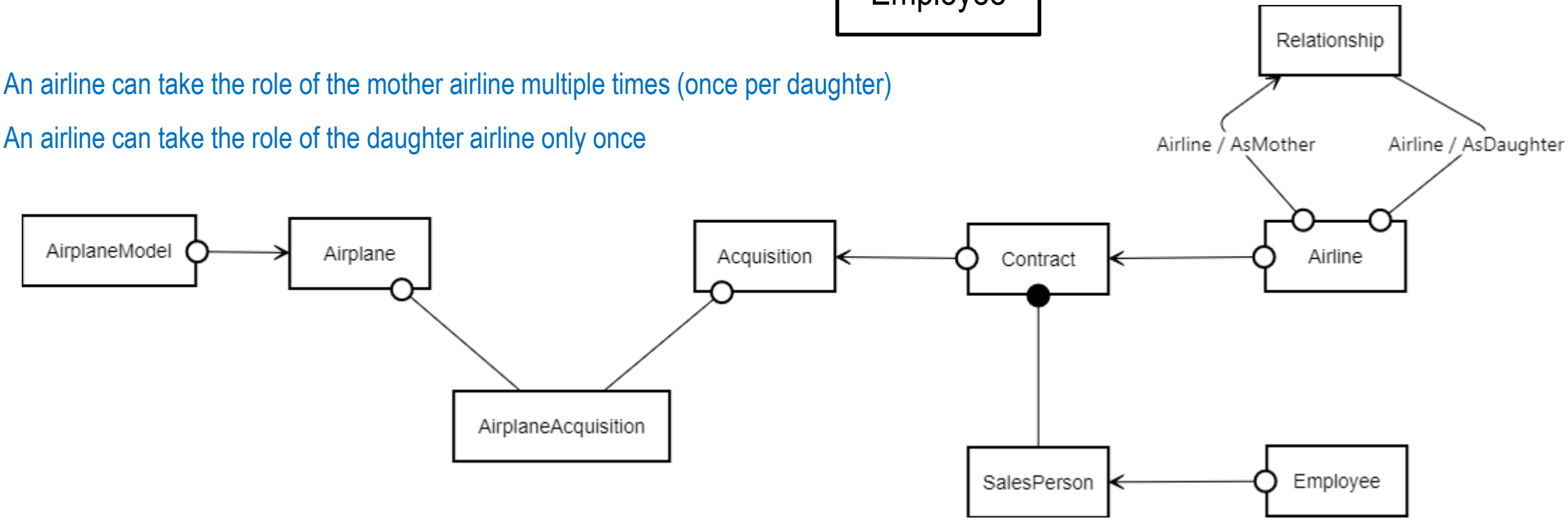
Note: Not stated explicitly in the requirements: a mother-daughter partnership is a 1 to many association, because a company can be daughter of at most one other company, while a company can have several daughter companies.

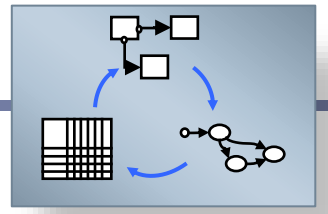
- Unary associations always need to be reified.

Boeing UML to EDG



- An airline can take the role of the mother airline multiple times (once per daughter)
- An airline can take the role of the daughter airline only once

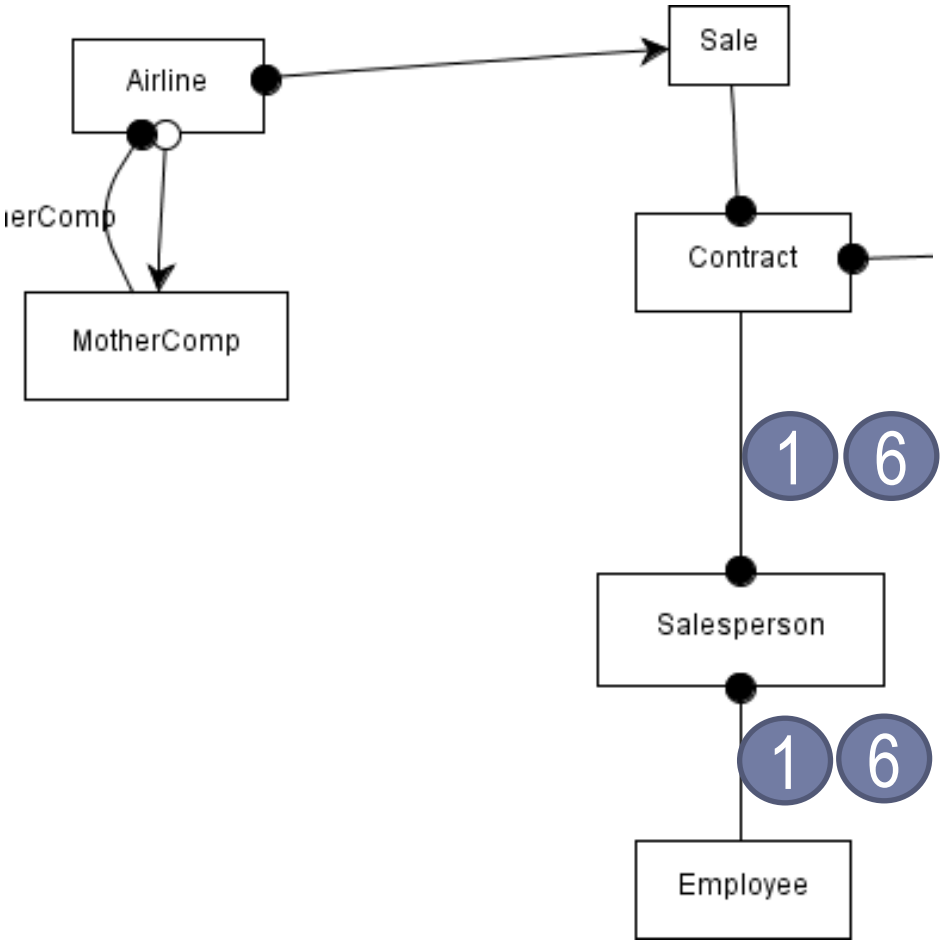




Boeing

Advice based on student solutions

Boeing - Feedback



1. Double check direction of association: which object exists first?

6. Double check cardinalities of associations

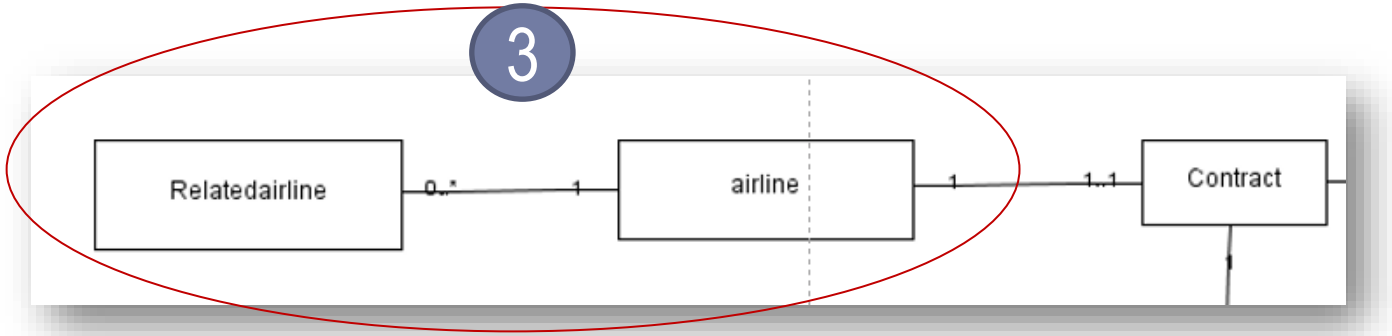
Suppose there are 10 salespeople.
How many employees can the company have ?

How many contracts can the company have ?

Boeing - Feedback

3. Different classes should not overlap in terms of instances

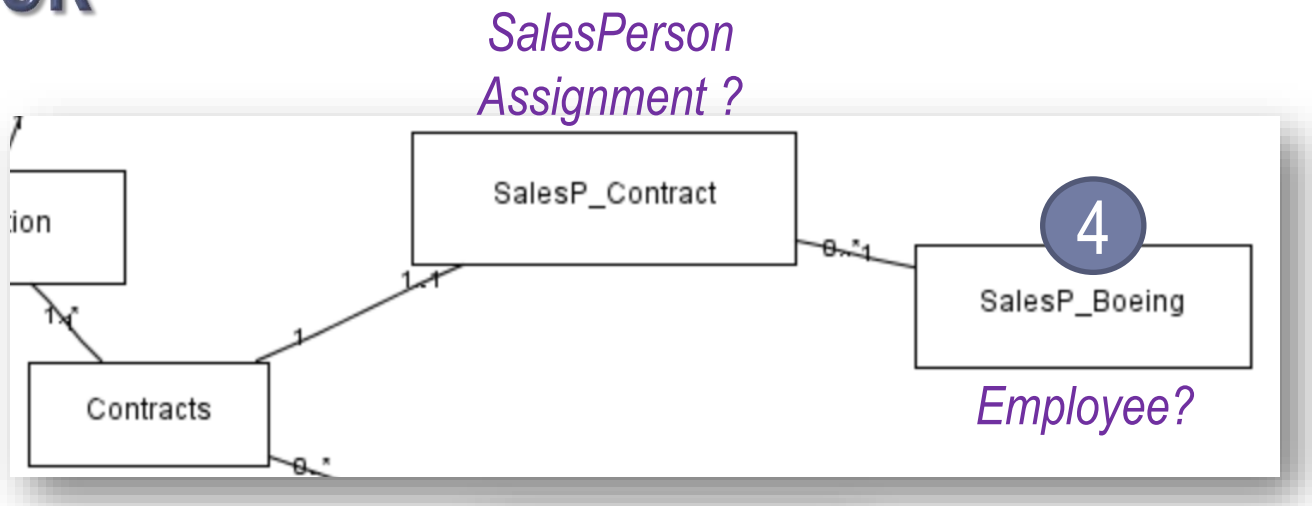
See chapter 8, Inheritance[1]

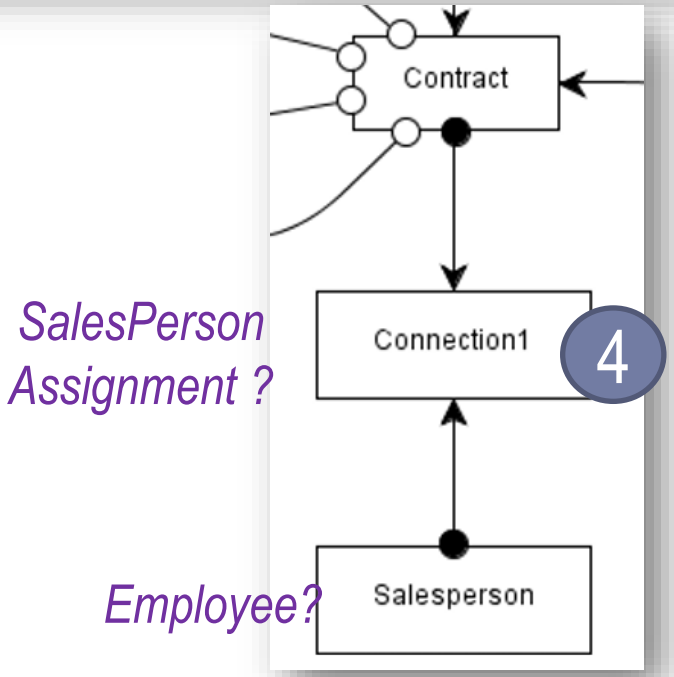


[1] https://link.springer.com/chapter/10.1007/978-3-319-10145-3_8

Boeing - Feedback

4. Have meaningful names for business objects

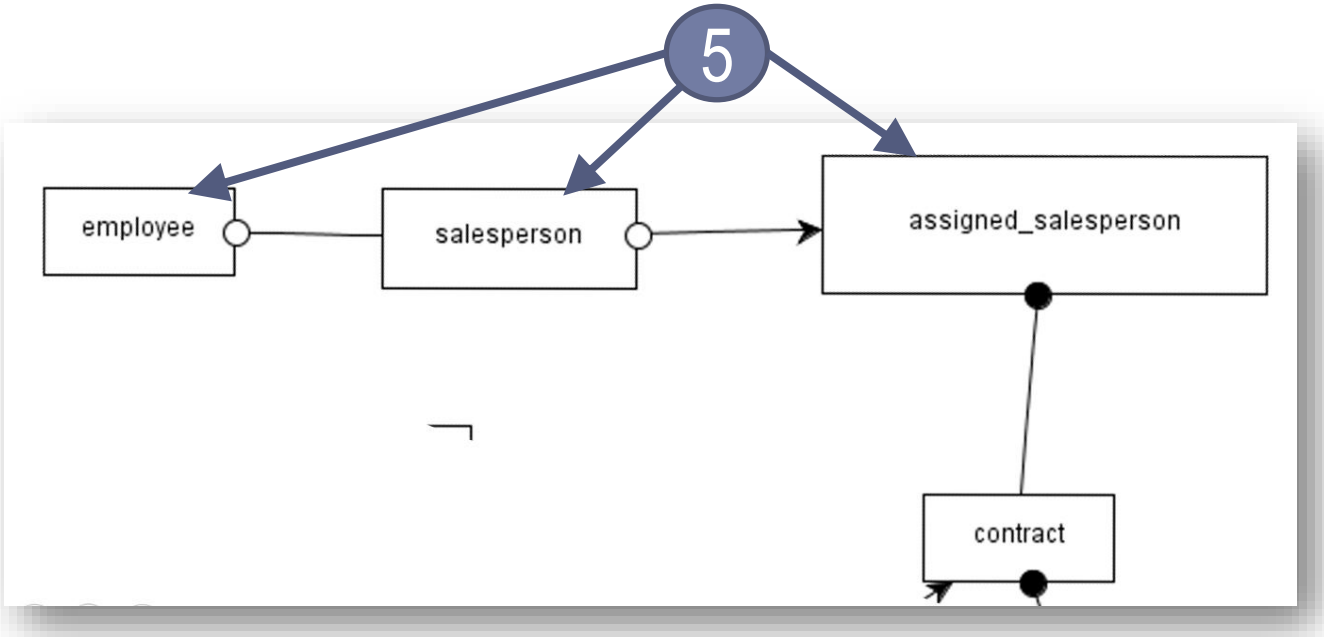




Boeing - Feedback

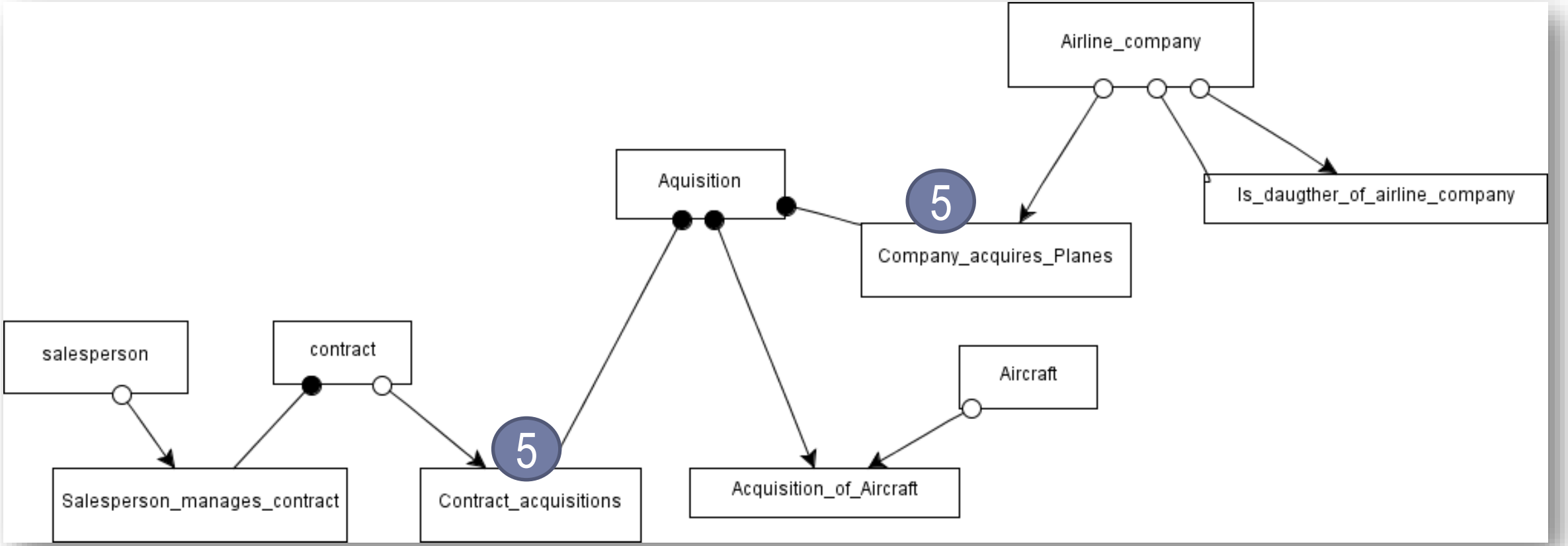
5. Do not reify more than necessary:

An employee is a salesperson because s/he is assigned in this role to a contract.



Boeing - Feedback

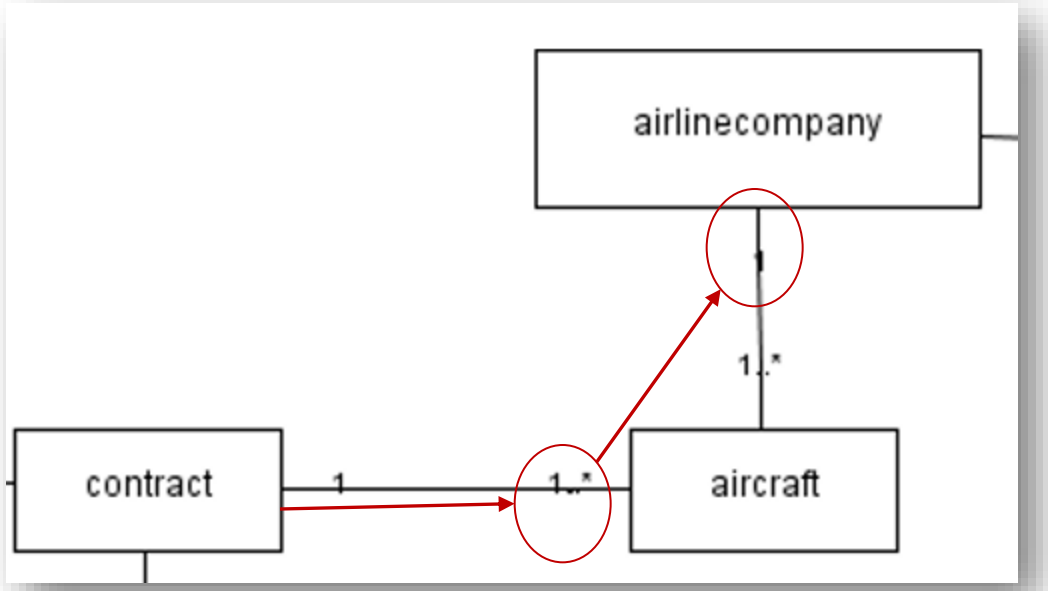
5. Do not reify more than necessary:

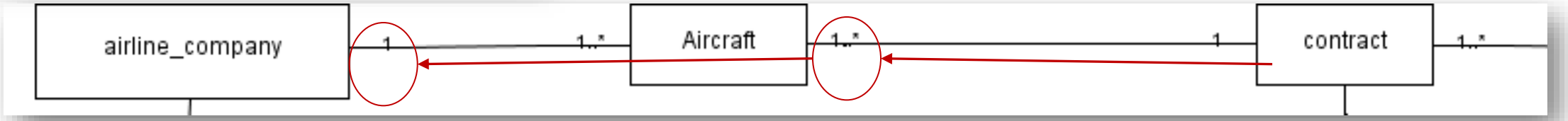


Boeing - Feedback

6. Double check cardinalities of (indirect) associations

How many airline companies can be associated to 1 contract ?



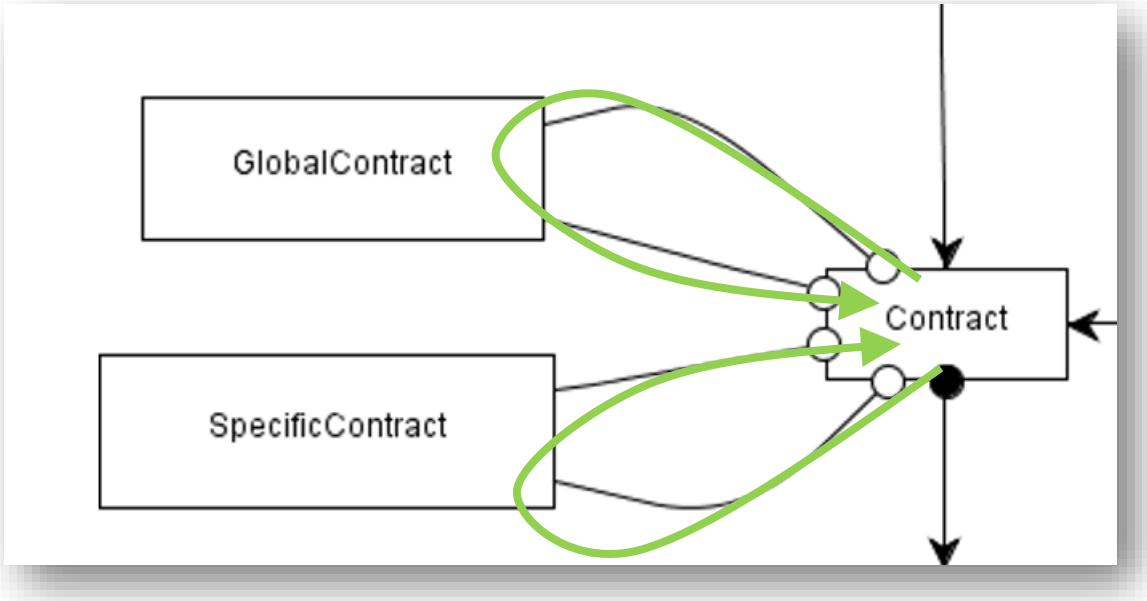


Boeing - Feedback

7. Not more associations than needed

Is one association the reverse of the other ?
Then only one needs to be modelled.

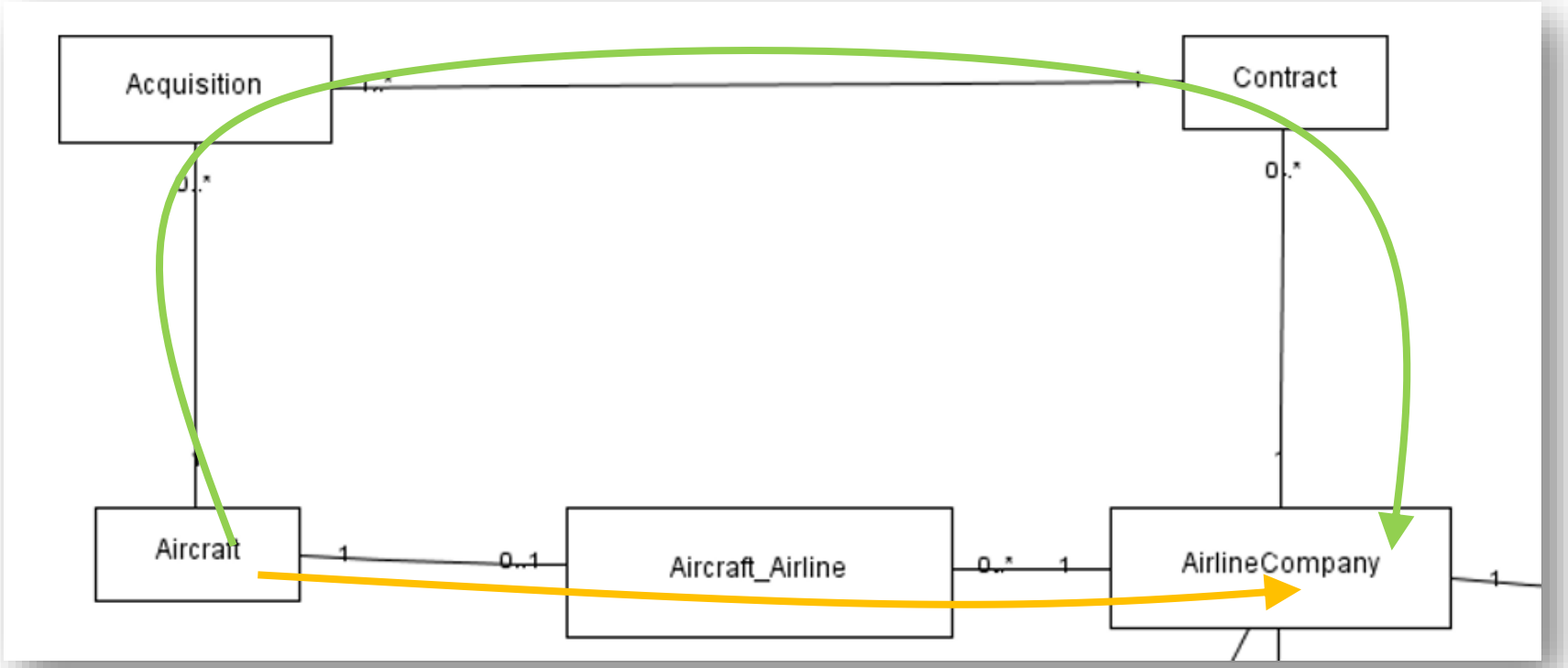
If C1 is a global contract for C2,
then C2 is a specific contract of C1 ?



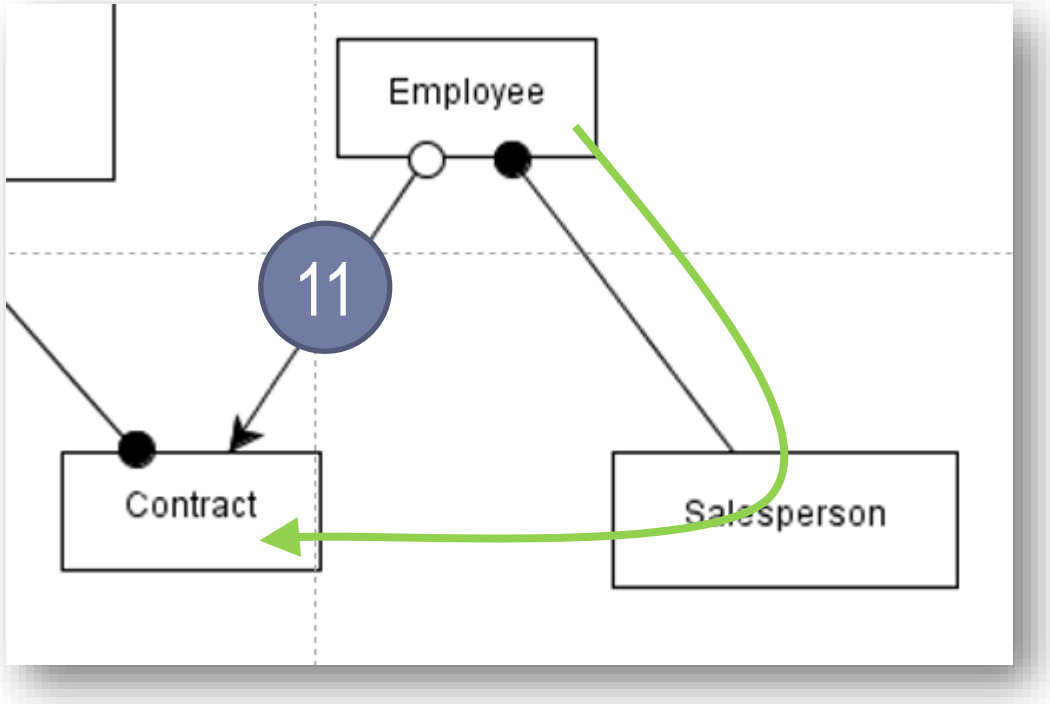
Boeing - Feedback

7. Not more associations than needed

Does one association contain the same information as the other ?
Then only one needs to be modelled.



Boeing - Feedback



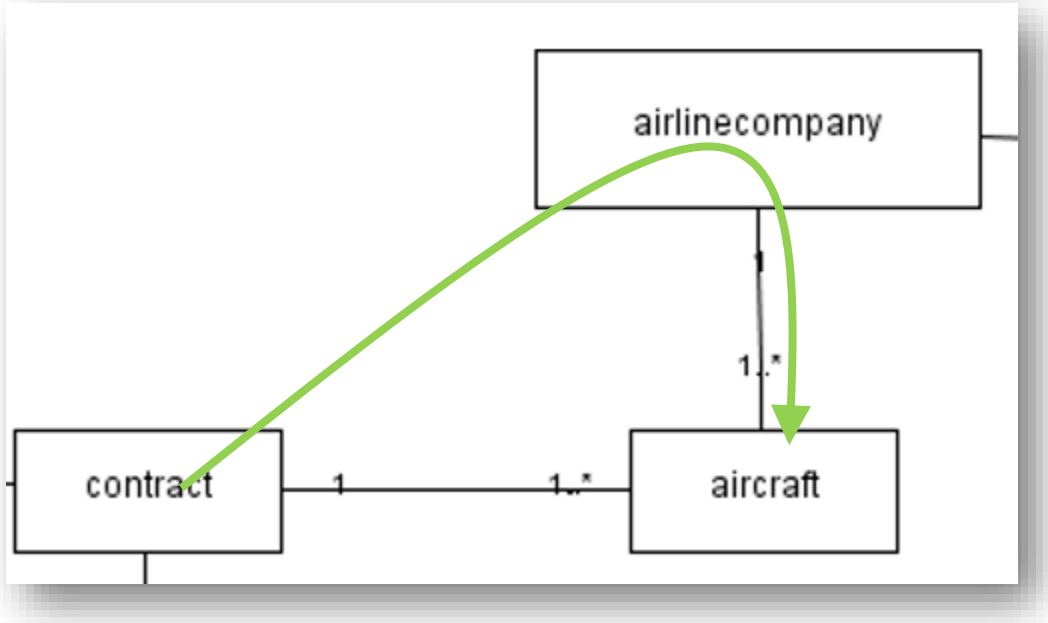
11. Do not confuse direct and indirect associations

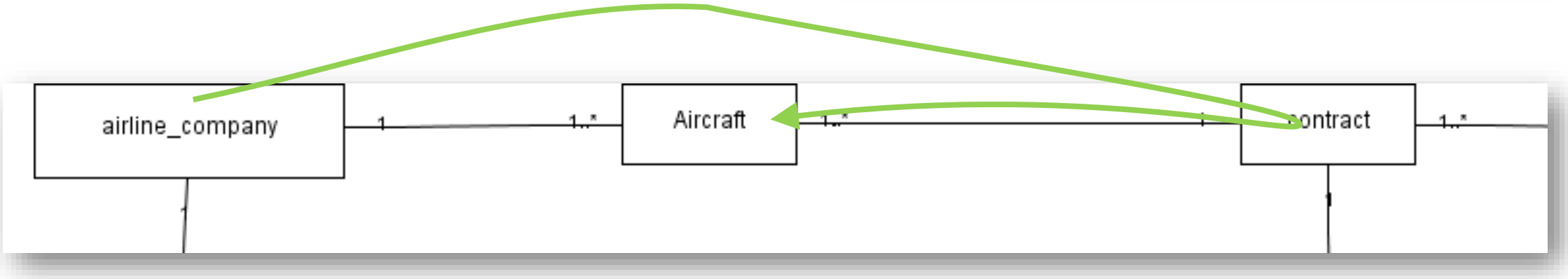
An Employee is connected to a contract because the Employee is assigned as a Salesperson to this Contract

Boeing - Feedback

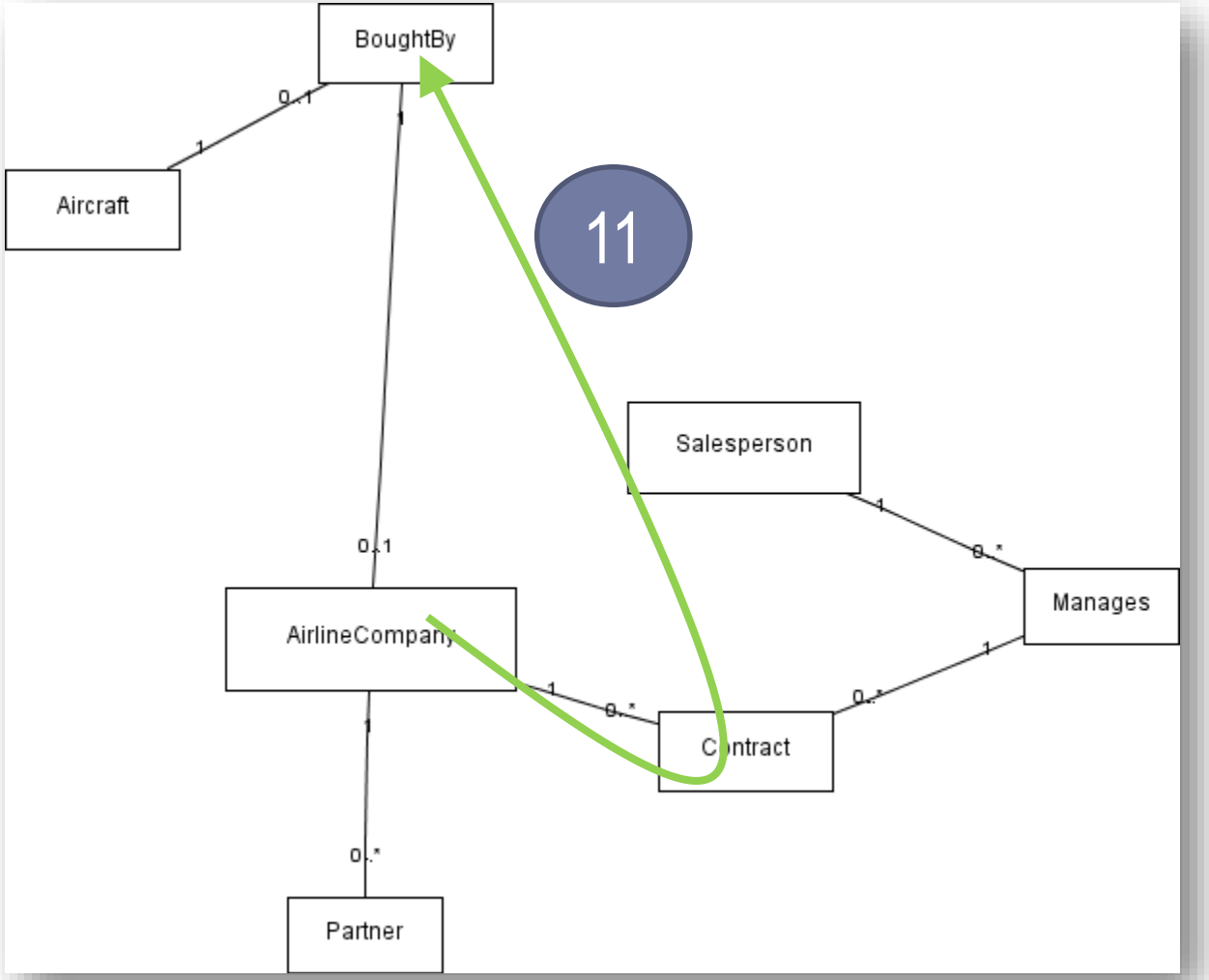
11. Do not confuse direct and indirect associations

An Airline company has an Aircraft, because the Airline Company has a contract through which this Aircraft was acquired





Boeing - Feedback



11. Do not confuse direct and indirect associations

An aircraft is bought by an Airline company, because there is a contract ==> a "BoughtBy" object can only exist in the context of a contract