Data and Process Modelling

3. Object-Role Modeling - CSDP Step 7

Marco Montali

KRDB Research Centre for Knowledge and Data
Faculty of Computer Science
Free University of Bozen-Bolzano

A.Y. 2014/2015

Further Constraints and Checks

CSDP Step 7

Add other constraints, and perform final checks

- Frequency constraint: to predicate about the number of times an entity must/can participate to a fact type.
- Final consistency checks (re-iterating if needed).

Occurrence Frequencies

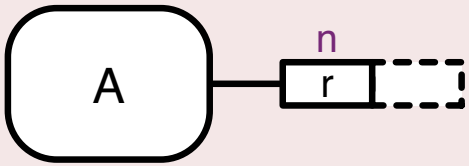
Local constraints specifying how many times an entity of a given type can/must play an attached role. Compound transactions are typically needed to populate the corresponding fact tables.

- Frequency constraint: positive integer n on top of a role - each entity of the connected type must appear *exactly n* times in the corresponding fact table.
  - If n $= 1$, it corresponds to an UC $\rightarrow$ the bar must be used.
- Frequency ranges: "$\leq n$" (with $n \geq 2$) - *at most n*; "$\geq n$" (with $n \geq 1$) - *at least n* (range can be also used when needed).
- Compound frequency constraint spans two or more roles.

Locality of frequency constraints

Frequency constraints apply to roles, not object types.

Locality principle

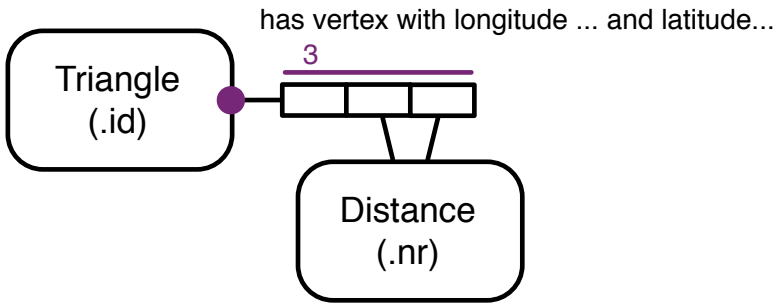


For each information base state: each member of $pop(r)$ occurs there **exactly n times**.
I.e., **if** an instance of A plays role r, it must do so **n times**.

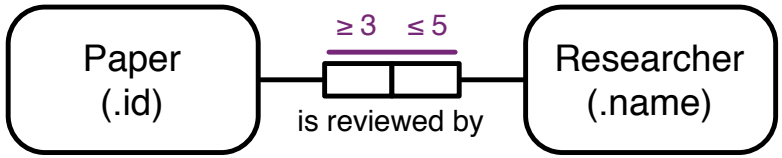
- The semantics differ from other conceptual modeling languages (such as E-R and UML).
- To reconstruct the usual UML-like interpretation, **mandatory participation** must be added on r.

Internal Frequency Constraints - Examples

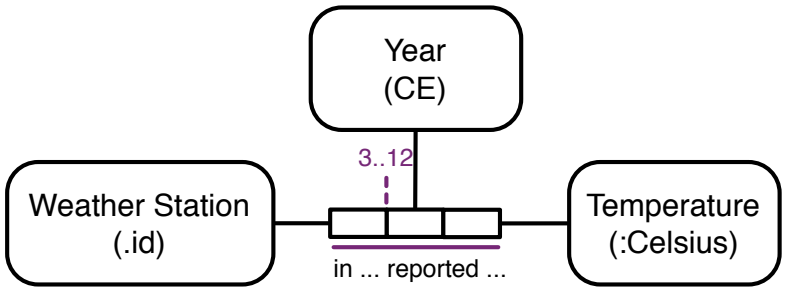
Exactly N.



Frequency ranges
(on the whiteboard: what about Submitted vs Reviewed Papers?).

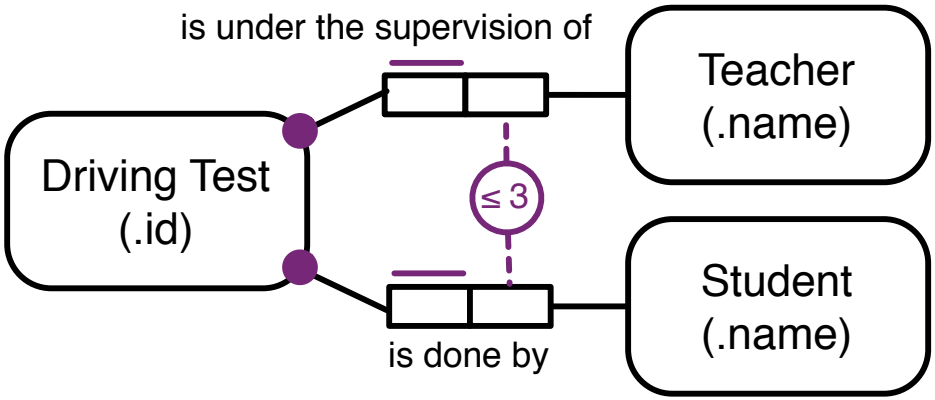


Compound.



External Frequency Constraints

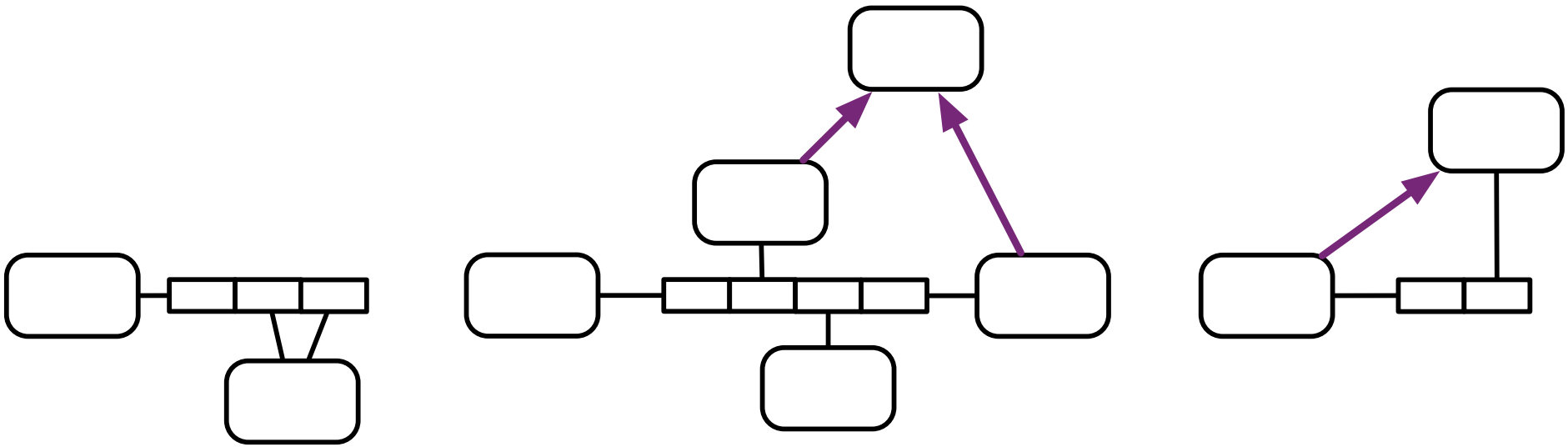
- Frequency constraints can be also span across roles belonging to different fact types.
- Semantics obtained by imposing frequency constraints over the corresponding columns in the conceptual join.
- Example: each pair Student-Teacher can participate to a driving test together at most three times.



Ring Constraint

Constraint applied to a pair of roles that are connected to the same object type, either directly or indirectly through sub/supertyping.

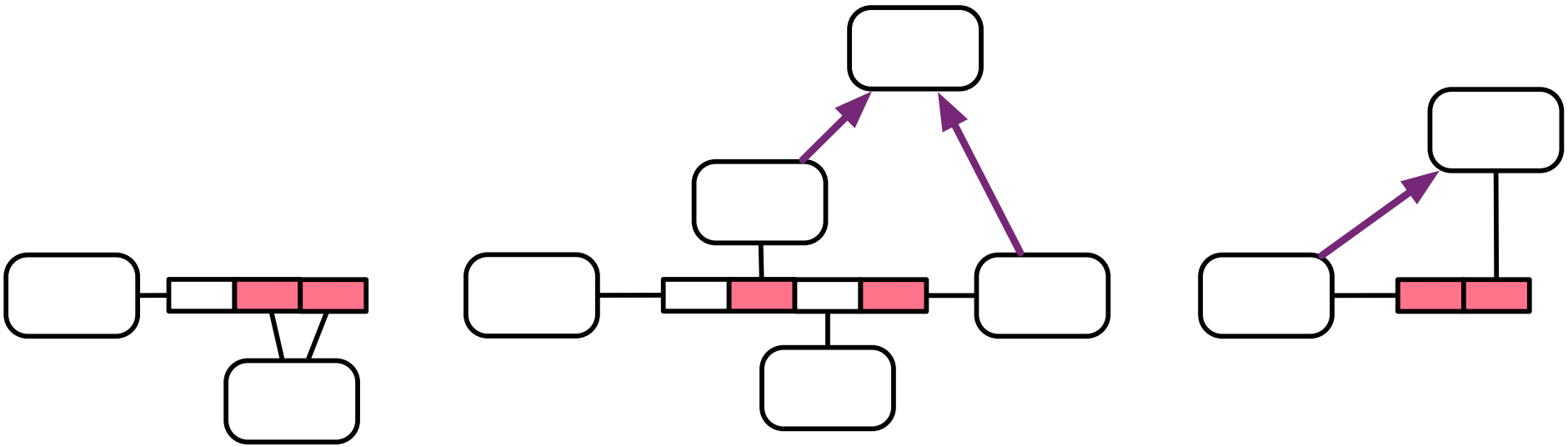
Which rings?



Ring Constraint

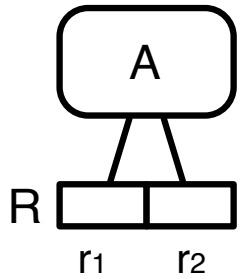
Constraint applied to a pair of roles that are connected to the same object type, either directly or indirectly through sub/supertyping.

Which rings?



Ring Constraint - Basics

- Prototypical setting:

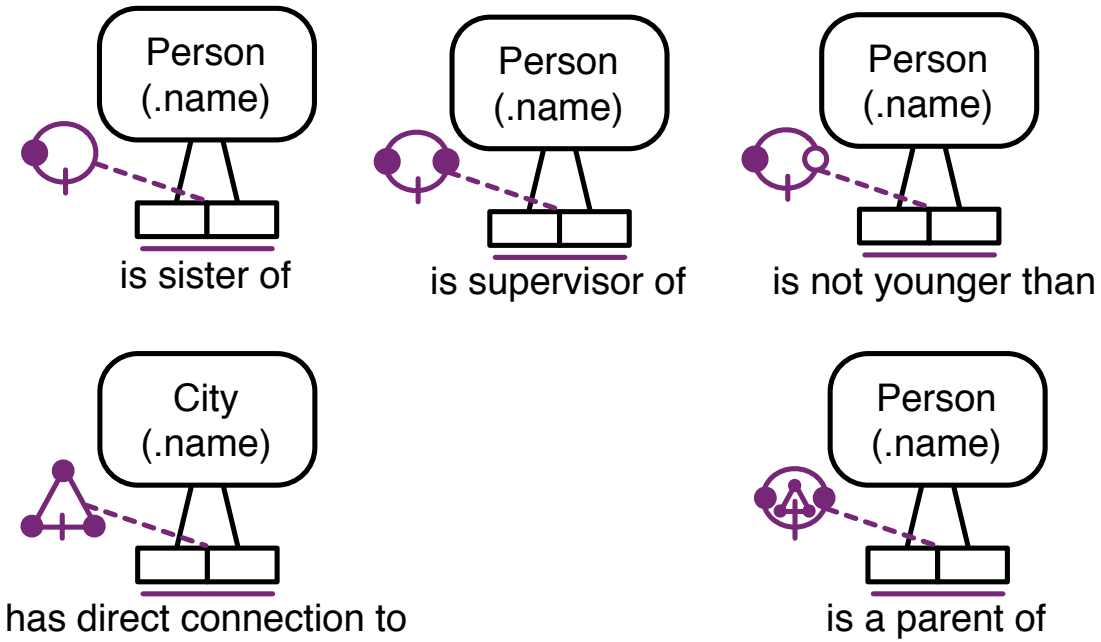


- R is a relation, that could enjoy different properties:
  - Reflexivity: $\forall x.xRx$.
  - Symmetry: $\forall x, y.xRy \rightarrow yRx$.
  - Transitititivity: $\forall x, y, z.xRy \wedge yRz \rightarrow xRz$.

  where all variables x, y, z range over $pop(r_1) \cup pop(r_2)$.
- These properties are "positive": they state how to derive *additional* information.
- Their negations can be thought as *constraints*, and are represented using stylized graphical icons remembering their semantics.
- Positive properties can also be represented by removing the "bar" attached to the icons.

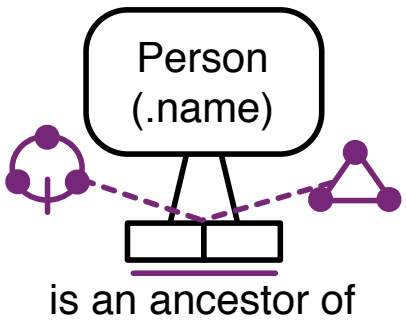
Ring Constraints - Types

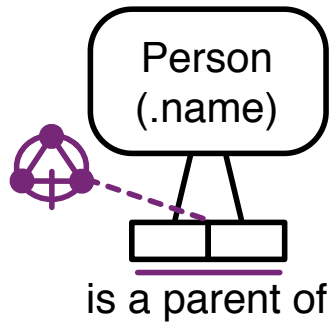
- Irreflexivity: $\forall x.\neg xRx$.
- Asymmetry: $\forall x, y.xRy \rightarrow \neg yRx$.
  - Obviously stronger than irreflexivity.
- Antisymmetry: $\forall x, y.x \neq y \wedge xRy \rightarrow \neg yRx$.
  - Is asymmetry without irreflexivity.
- Intransitivity: $\forall x, y, z.xRy \wedge yRz \rightarrow \neg xRz$.
- Can be also combined.



Ring Constraints - Cycles

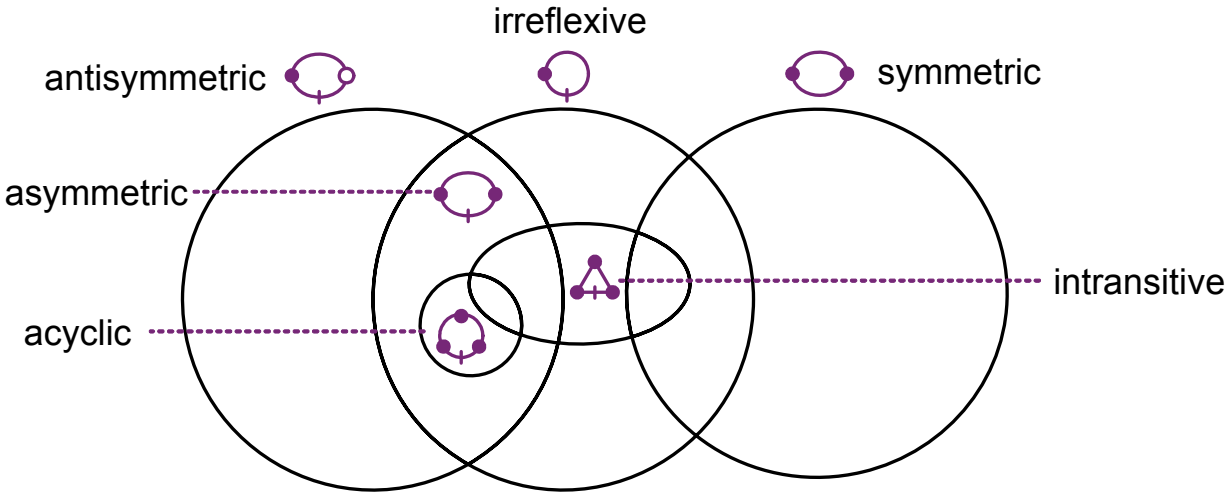
- What about cycles in the ring?
- There are situations in which we want to exclude that the entity is indirectly connected to itself through the repeated application of the ring relationship.
  - E.g., a Person cannot be ancestor of herself.
- In this case, we generalize asymmetry to acyclicity
- Can be combined with other ring constraints, e.g., with intransitivity.
- It is an expensive constraint to be checked, because it is recursive (transitive closure!)





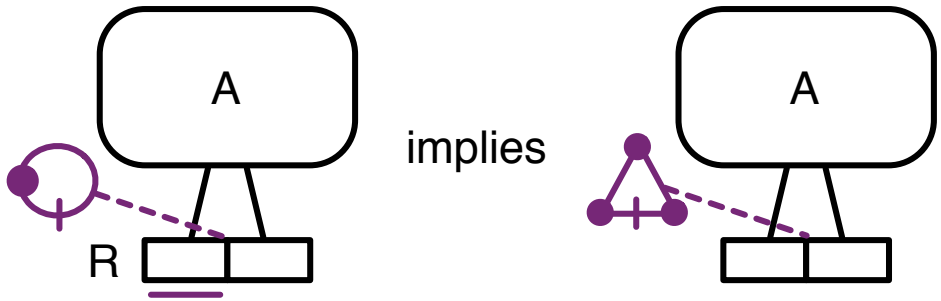
Relationships Among Ring Constraints

Combination of ring constraints can easily lead to redundancy or inconsistency.



The same holds when considering the combination with other constraints.

- Exclusion constraint implies asymmetry and in turn irreflexivity.
- Irreflexivity and functionality imply together intransitivity.



Final Checks

Final verification about the correctness and suitability of the conceptual schema

1. Internal consistence: each role of the schema is strong satisfiable, i.e., can be populated.
2. External consistence: the conceptual schema agrees with the sample data and requirements.
3. Lack of redundancy: check that no elementary fact can appear twice (or that redundancy is "controlled"/"safe").
   - This include a decision about whether to keep redundancy in the information system or in the external views.
4. Completeness: check whether the conceptual schema "covers" all the original requirements.
   - Systematic analysis of each requirement, one by one.

Iteration until the conceptual schema is ok.

One Diagram, Many Errors