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# ER Model

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## ❖ Entity-Relationship Data Modelling

The world is viewed as a collection of **inter-related** entities.

ER has three major modelling constructs:

- **attribute**: **data item** describing a property of interest
- **entity**: collection of attributes describing **object** of interest
- **relationship**: **association** between entities (objects)

The ER model is not a standard, so notational variations exist

Lecture notes use notation from SKS and GUW books (simple)

## ❖ Entity-Relationship (ER) Diagrams

ER diagrams are a graphical tool for data modelling.

An ER diagram consists of:

- a collection of entity set definitions
- a collection of relationship set definitions
- attributes associated with entity and relationship sets
- connections between entity and relationship sets

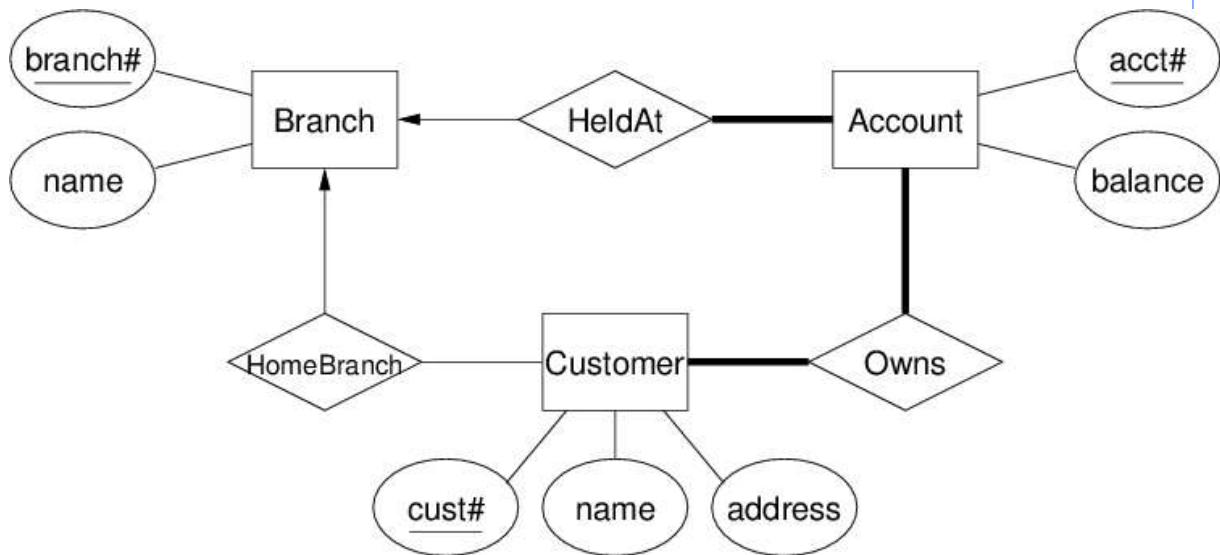
Terminology abuse:

- we say "entity" when we mean "entity set"
- we say "relationship" when we mean "relationship sets"
- we say "entity instance" to refer to a particular entity

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## ❖ Entity-Relationship (ER) Diagrams (cont)

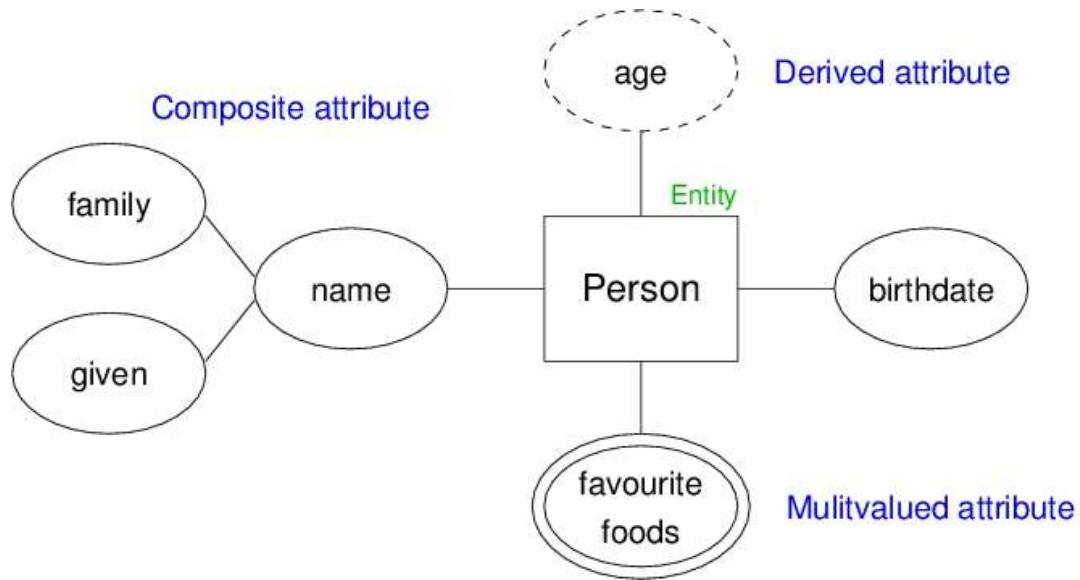
Example ER diagram:



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## ❖ Entity-Relationship (ER) Diagrams (cont)

Example of attribute notations:



## ❖ Entity Sets

An **entity set** can be viewed as either:

- a set of entities with the same set of attributes (extensional)
- an abstract description of a class of entities (intensional)

**Key (superkey):** any set of attributes

- whose set of values are distinct over entity set
- natural (e.g., name+address+birthday) or artificial (e.g., SSN)

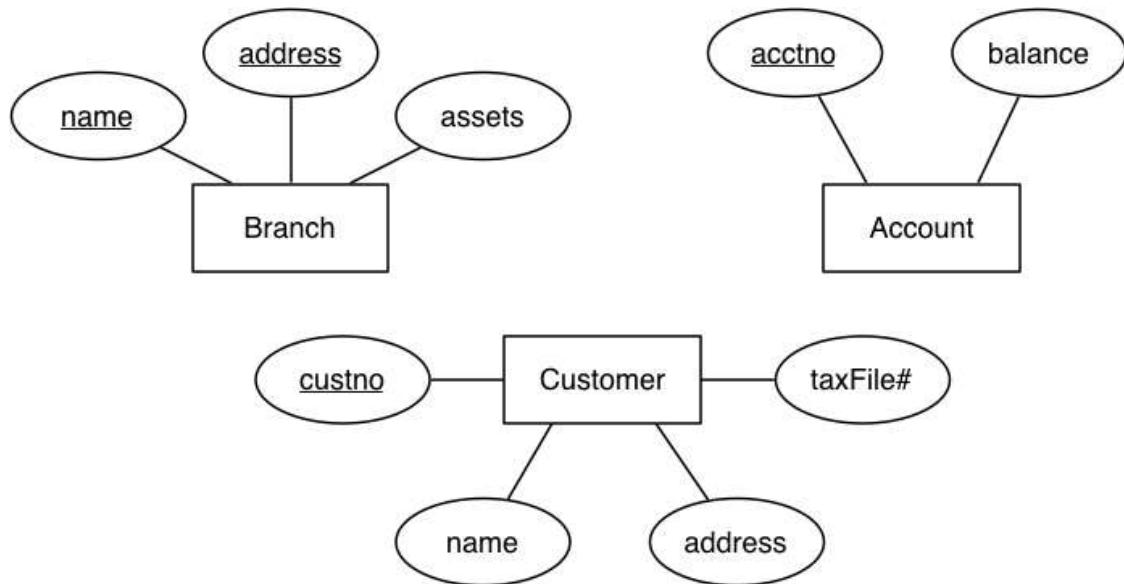
**Candidate key** = minimal superkey (no subset is a key)

**Primary key** = candidate key chosen by DB designer

Keys are indicated in ER diagrams by underlining

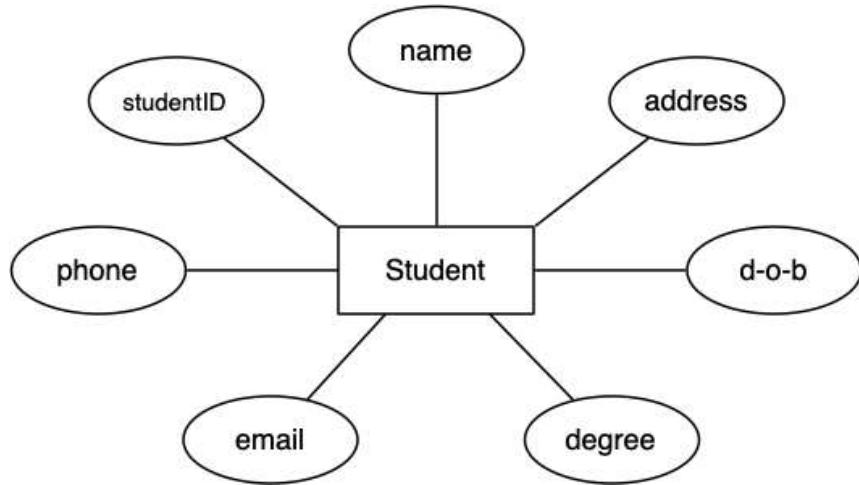
## ❖ Keys

Sometimes primary keys are obvious ...



## ❖ Example: Identifying Keys

Candidate keys in the following ER diagram ...



Possibilities: {studentID}, {phone}, {email},  
{name,address,d-o-b}?

## ❖ Relationship Sets

**Relationship:** an association among several entities

- e.g., Customer(9876) **is the owner of** Account(12345)

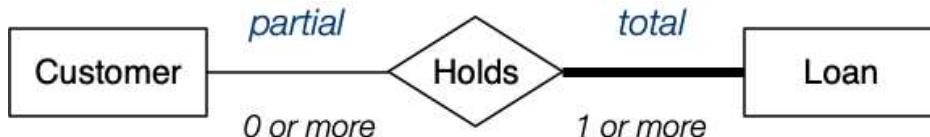
**Relationship set:** collection of relationships of the same type

**Degree** = # entities involved in reln (in ER model,  $\geq 2$ )

**Cardinality** = # associated entities on each side of reln

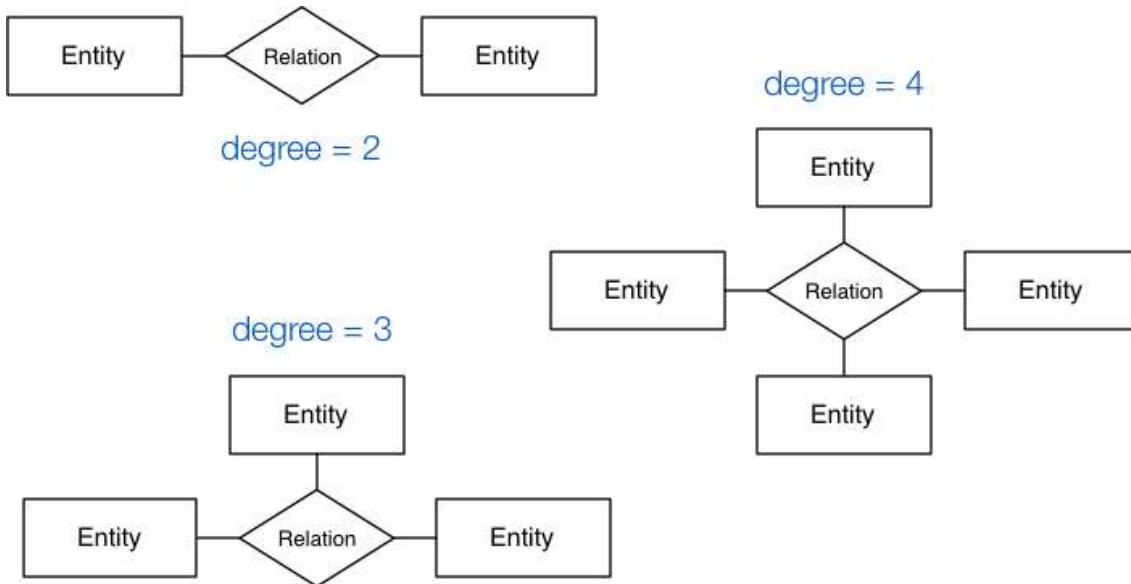
**Participation** = must every entity be in the relationship

**Example:** relationship participation



## ❖ Relationship Sets (cont)

Examples: relationship degree



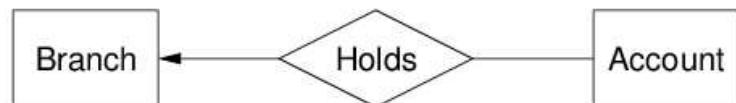
## ❖ Relationship Sets (cont)

Examples: relationship cardinality

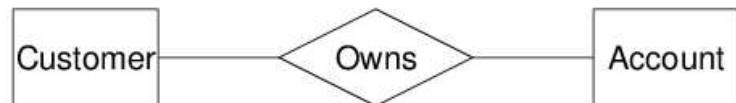
one-to-one



one-to-many

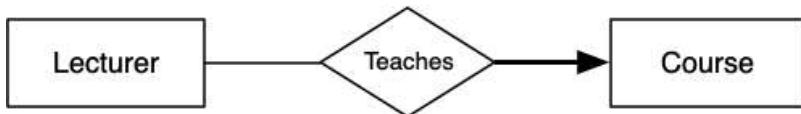


many-to-many

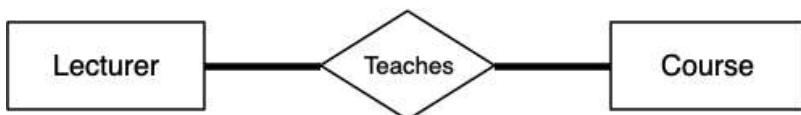


## ❖ Example: Relationship Semantics

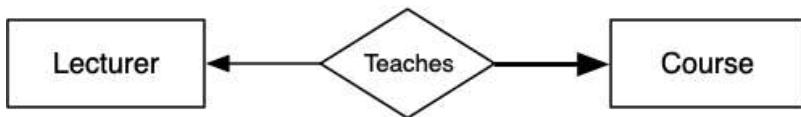
Semantics of the following relationships ...



*A lecturer may teach one course  
Every course is taught by 1 or more lecturers*



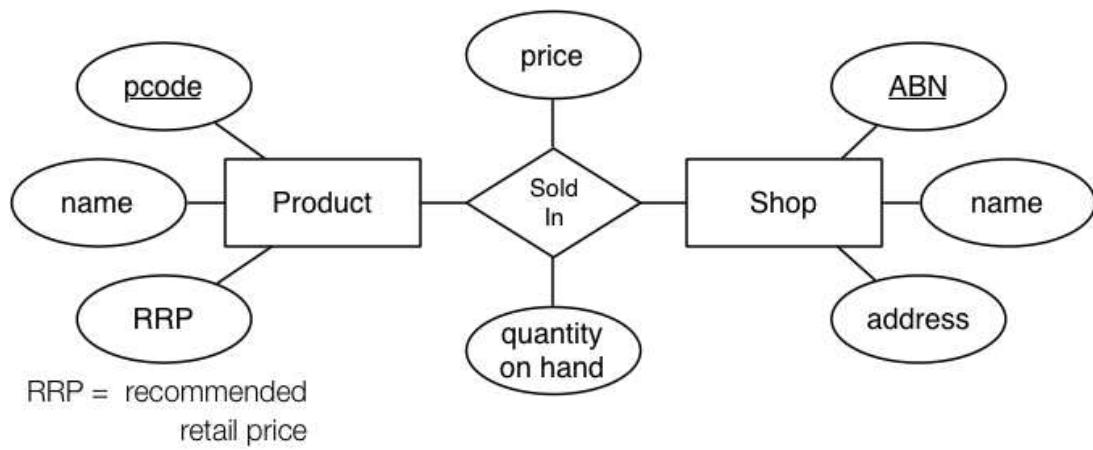
*Every lecturer teaches one or more courses  
Every course is taught by 1 or more lecturers*



*Every lecturer may teach one course  
Every course is taught by one lecturer*

## ❖ Example: Relationship Semantics (cont)

In some cases, a relationship needs associated attributes.



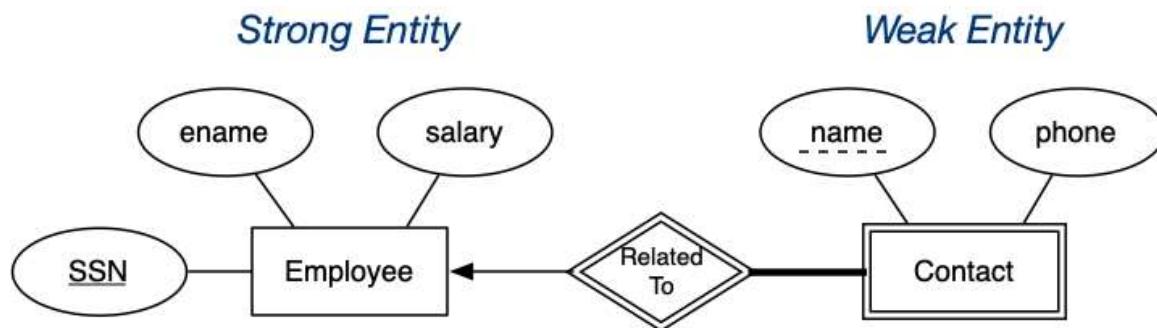
(Price and quantity are related to products in a particular shop)

## ❖ Weak Entity Sets

### Weak entities

- exist only because of association with strong entities.
- have no key of their own; have a **discriminator**

Example:



## ❖ Subclasses and Inheritance

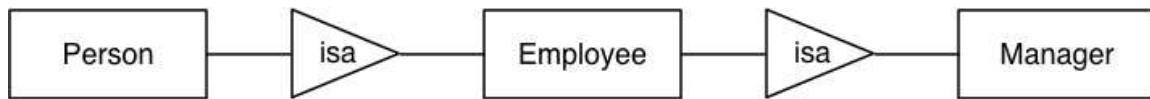
A **subclass** of an entity set  $A$  is a set of entities:

- with all attributes of  $A$ , plus (usually) its own attributes
- that is involved in all of  $A$ 's relationships, plus its own

Properties of subclasses:

- **overlapping** or **disjoint** (can an entity be in multiple subclasses?)
- **total** or **partial** (does every entity have to also be in a subclass?)

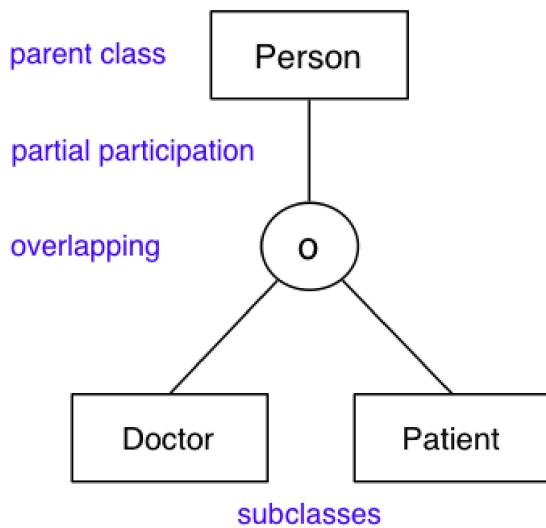
Special case: entity has one subclass ("B **is-a** A" specialisation)



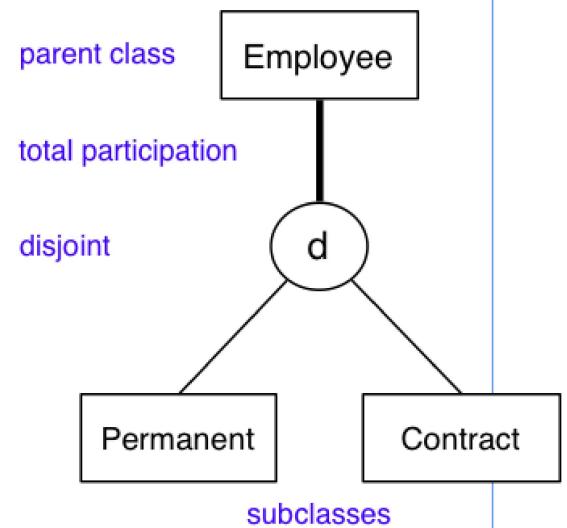
## ❖ Subclasses and Inheritance (cont)

Example:

*A person may be a doctor and/or may be a patient or may be neither*



*Every employee is either a permanent employee or works under a contract*



## ❖ Design Using the ER Model

ER model: simple, powerful set of data modelling tools

Some considerations in designing ER models:

- should an "object" be represented by an attribute or entity?
- is a "concept" best expressed as an entity or relationship?
- should we use  $n$ -way relationship or several 2-way relationships?
- is an "object" a strong or weak entity? (usually strong)
- are there subclasses/superclasses within the entities?

Answers to above are worked out by *thinking* about the application domain.

## ❖ Large ER Diagrams

ER diagrams are typically too large to fit on a single screen  
(or a single sheet of paper, if printing)

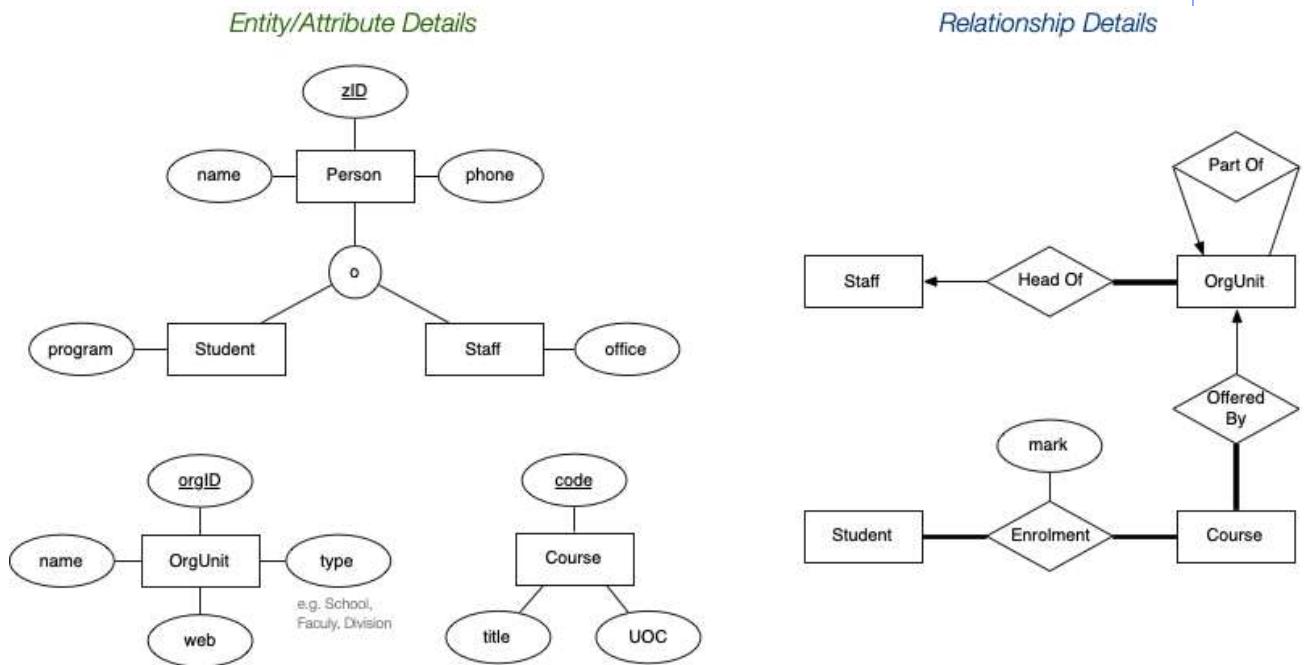
One commonly used strategy:

- define entity sets separately, showing attributes
- combine entities and relationships on a single diagram  
(but without showing entity attributes)
- if very large design, may use several linked diagrams

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## ❖ Large ER Diagrams (cont)

Example of drawing large ER diagram:



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## ❖ Summary of ER

ER model is popular for doing conceptual design

- high-level, models relatively easy to understand
- good expressive power, can capture many details

Basic constructs: entities, relationships, attributes

Relationship constraints: total / partial, n:m / 1:n / 1:1

Other constructs: inheritance hierarchies, weak entities

Many notational variants of ER exist  
(especially in the expression of constraints on relationships)

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