Relational Models

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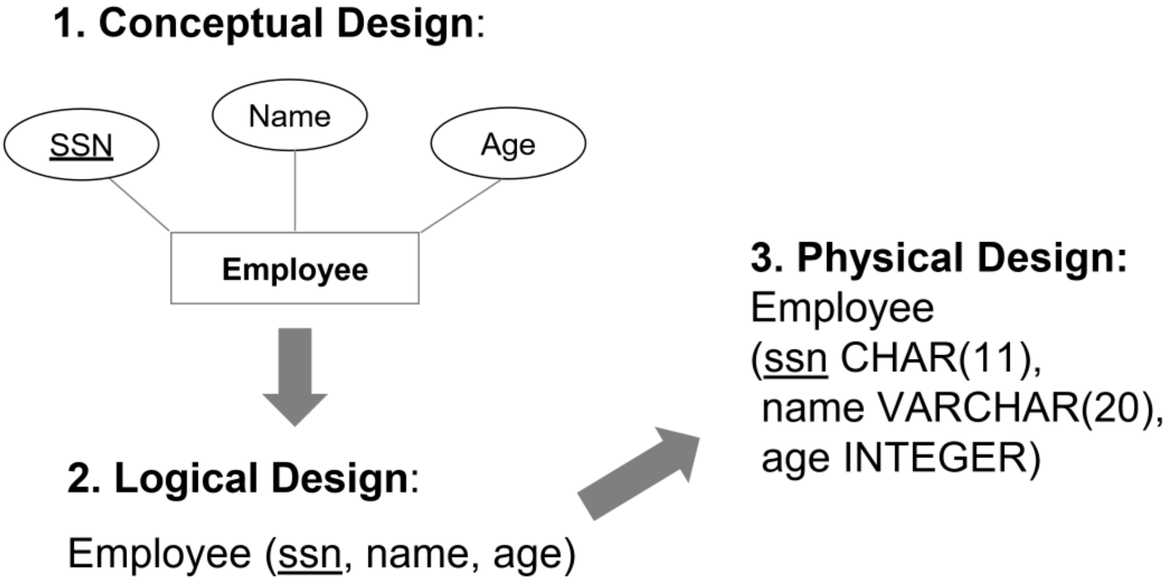
Definitions

- **data model**: transforms real world objects into structures a computer can store
    - many approaches: relational, ER, object-oriented, network, hierarchical, …
- **relational model**:
    - rows (Tuples/records)
    - columns (attributes/fields)
    - primary keys and foreign keys to link relations
- **relational database**: set of relations
- **relation**: consists of schema + instance
    - **schema**: name of relation plus name and type of each attribute
    - **instance**: **table** with rows and columns
        - **cardinality**: number of rows
        - **degree/arity**: number of fields
    - consider relation a *set of rows/tuples*
    - all rows are **distinct and unordered**
- logical design: **entity set** → **relation**
- physical design: select data types



1. Conceptual Design:

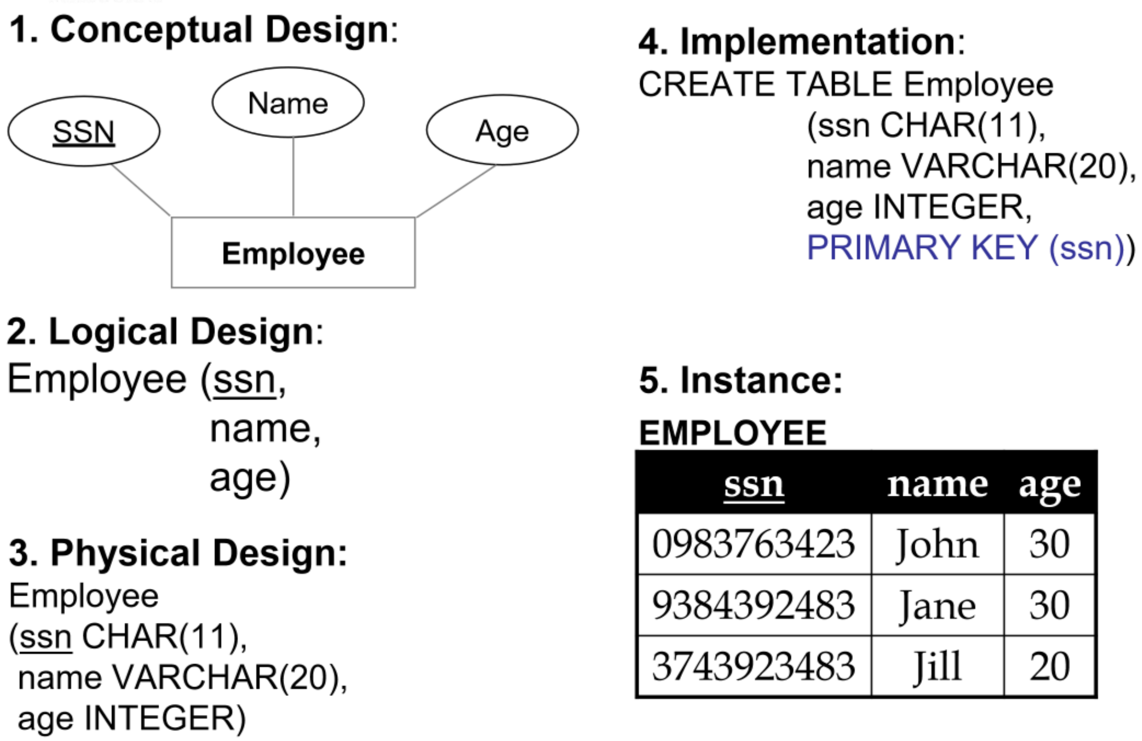
2. Logical Design:

Employee (ssn, name, age)

3. Physical Design:

Employee
(ssn CHAR(11),
name VARCHAR(20),
age INTEGER)

Figure 1: database_design



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2. Logical Design:

Employee (ssn,
name,
age)

3. Physical Design:

Employee
(ssn CHAR(11),
name VARCHAR(20),
age INTEGER)

4. Implementation:

```
CREATE TABLE Employee
         (ssn CHAR(11),
         name VARCHAR(20),
         age INTEGER,
         PRIMARY KEY (ssn))
```

5. Instance:

EMPLOYEE

ssn	name	age
0983763423	John	30
9384392483	Jane	30
3743923483	Jill	20

Figure 2: database_cycle

Keys

- keys associate tuples/rows in different relations
- **integrity constraint** [TODO]
- **superkey**: set of fields used to uniquely identify a record
- **key**: minimal subset that uniquely identifies a record
  - set of fields for a relation if it is a superkey and no subset is a superkey
- **primary key**: key chosen
  - others are **candidate keys**
  - every relation has a primary key
  - 'PRIMARY KEY ()
- **foreign key**: set of fields in one relation used to refer to a tuple/row in another relation
  - must correspond to primary key of other relation
- **referential integrity**: implies all foreign key constraints are enforced in DBMS
  - `FOREIGN KEY (<key>)REFERENCES <table>`
  - i.e. referenced tuple exists in referenced table
  - can define behaviour on tuple deletion: disallow deletion of referenced object, cascade deletion through relations that reference the object, …

Integrity Constraints

- **integrity constraint**: condition must be true for *any* instance of database
  - e.g. **domain constraints**
  - ICs specified when schema defined
  - ICs checked when relations modified
- **legal** instance $\iff$ all specified ICs satisfied
  - DBMS should not allow illegal instances.

Logical Design

Multi-valued Attributes

- **multi-valued attributes**: options

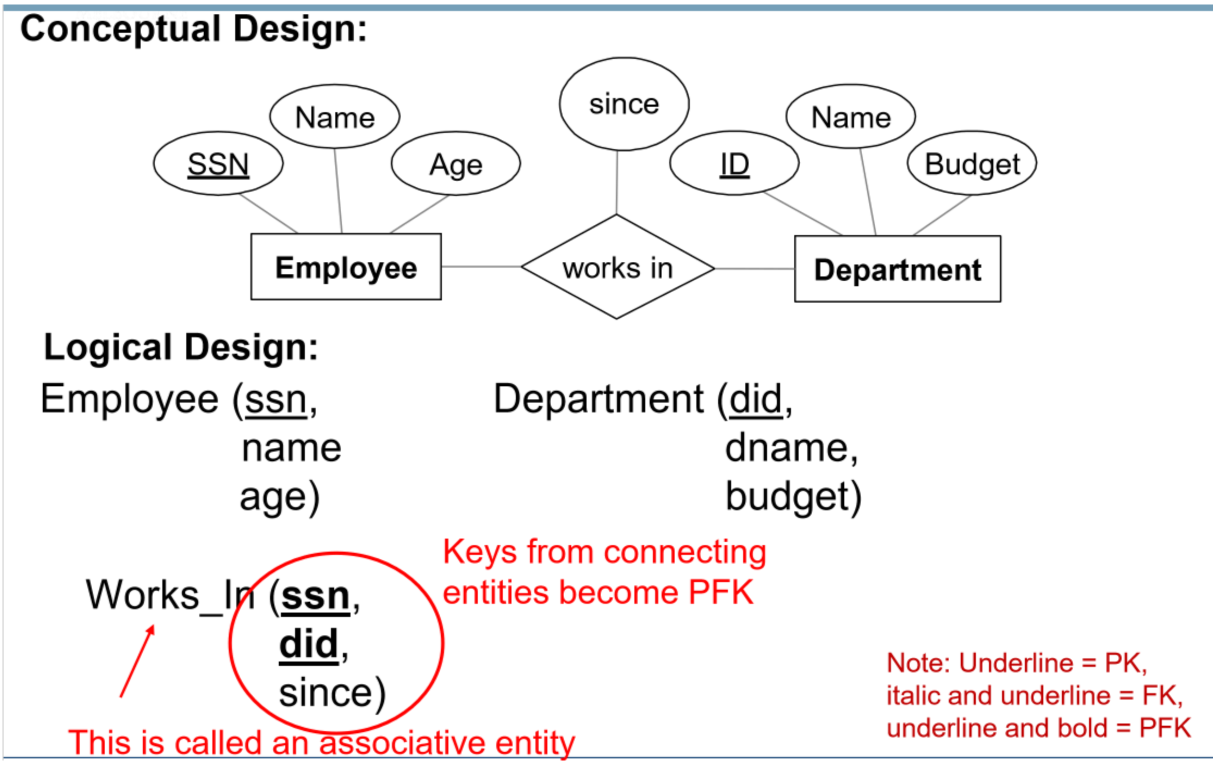
  - unpack/flatten when converting to logical design
  - otherwise create a lookup table
  - e.g. multiple phone numbers for an employee ⇒ (home_num, work_num)

Composite Attributes

- e.g. address: flatten by breaking into components (postcode, street name, street num)

Many-to-many relationships

- **many-to-many** relationship → relation
  - attributes include:
    - keys for each participating entity set (as foreign keys)
      - set of attributes forms **superkey** of relation
    - all descriptive attributes



Conceptual Design:

Logical Design:

Employee (ssn,
name
age)

Department (did,
dname,
budget)

Works_In (**ssn**,
did,
since)

Keys from connecting entities become PFK

This is called an associative entity

Note: Underline = PK,
italic and underline = FK,
underline and bold = PFK

Figure 3: many_to_many_logical_design

Ternary Relationships

[TODO]