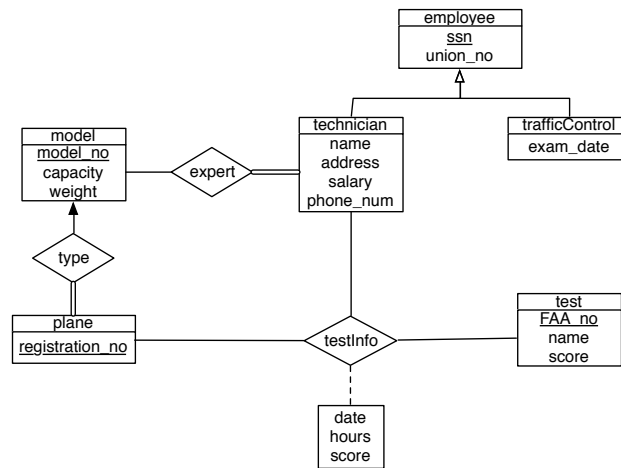# Functional Dependencies (Part 1)

CISC637, Lecture #8

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Airport Requirements

1. Every airplane has a registration number, and each airplane is of a specific model.

2. The airport accommodates a number of airplane models, and each model is identified by a model number (e.g., DC-10) and has a capacity and weight.

3. A number of technicians work at the airport. You need to store the name, SSN, address, phone number, and salary of each technician.

4. Each technician is an expert on one or more plane models, and his or her expertise may overlap with that of other technicians. This information about technicians must also be recorded.

5. Traffic controllers must have an annual medical exam. For each traffic controller, you must store the date of the most recent exam.

6. All airport employees (including technicians) belong to one union. You must store the union membership number of each employee. You can assume that each employee is uniquely identified by a social security number.

7. The airport has a number of tests that are used periodically to ensure that airplanes are still airworthy. Each test has a Federal Aviation Administration (FAA) test number, a name, and a maximum possible score.

8. The FAA requires the airport to keep track of each time a given airplane is tested by a given technician using a given test. For each testing event, the information needed is the date, the number of hours the technician spent doing the test, and the score the airplane received on the test.

Airport E-R Diagram

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Functional Dependencies

- A **functional dependency** is a type of integrity constraint related to relation keys
  - A set of fields X *functionally determine* a set of fields Y:
    - If we are given values of X, then we can get values of Y uniquely
  - We write X → Y to indicate functional dependency
    - We say "X functionally determines Y"
    - or "Y is determined by X"

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Some FDs for the Airport

- Candidate key FDs:
  - reg_no → reg_no
  - model_no → model_no, capacity, weight
  - FAA_no → FAA_no, name, maxscore
  - ssn → ssn, union_no, name, address, salary, phone_num
  - ssn → ssn, union_no, exam_date

- Additional FDs derived from requirements:
  - reg_no → model_no
  - union_no → ssn
  - ssn, FAA_no, reg_no → date, hours, score

- Superkey FDs:
  - model_no, capacity → model_no, capacity, weight
  - ssn, union_no → ssn, union_no, exam_date
  - …

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FDs: A Formal Definition

- Field(s) X *functionally determine* field(s) Y iff
  - for *every* possible instance r of a relation R with fields X,Y
    - for *any* two records t1, t2
      - if $\pi_X(t1) = \pi_X(t2)$
      - then $\pi_Y(t1) = \pi_Y(t2)$
  - If that is the case, we say the functional dependency X → Y *holds* on R

- $\pi_X(t1)$ is read as "the projection of t1 to fields X"
  - equivalent to SQL statement
    `SELECT X FROM R WHERE [record is t1]`

- So: if I select fields X from t1 and fields X from t2, and the values of X are equivalent, then fields Y must be equivalent as well

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FDs: Formal Definitions

- "Satisfied" versus "holds":
  - A functional dependency is *satisfied* on a relation instance R if it is true for every record that is actually in R
  - A functional dependency *holds* on a relation R if it is true for every possible record that could ever be in R

- Types of FDs:
  - Superkey, candidate key, trivial
  - Some FDs are none of the above

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