Reasoning with FDs

Designing Schemas

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Kevin C.C. Chang, Professor

Computer Science @ Illinois

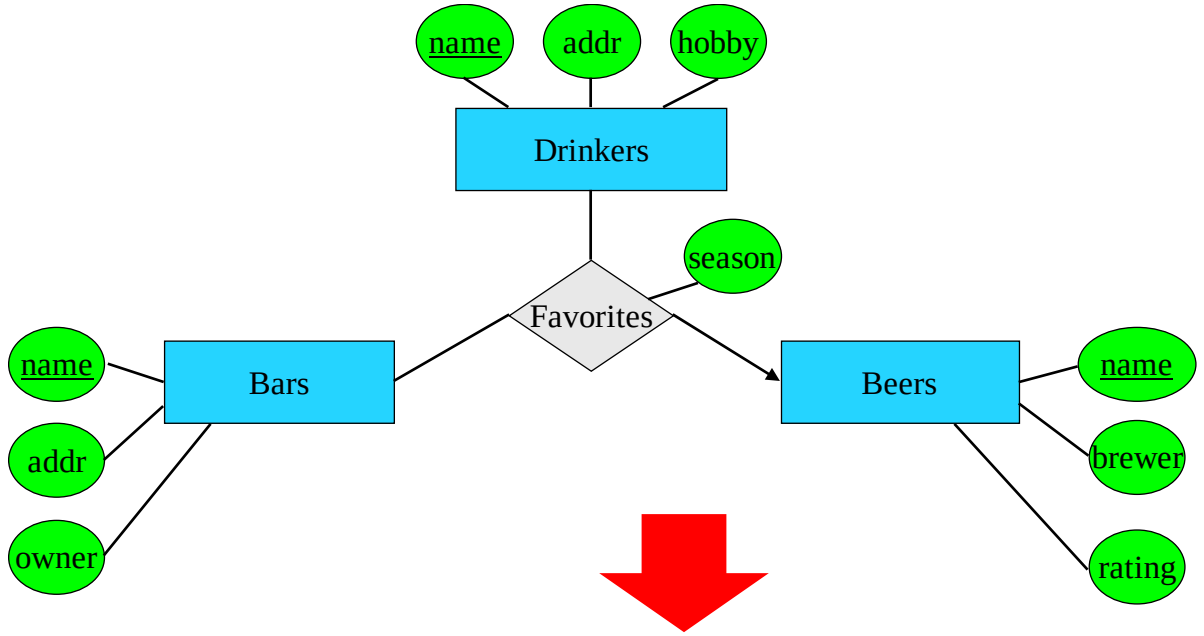
Learning Objectives

By the end of this video, you will be able to:

- Describe why reasoning with FDs is useful.
- State Armstrong's Axioms and their derived rules.
- Determine if an FD holds based on a given set of FDs.

Why Do I Need to Reason?

- Recall the Favorites relation:
- How to know {drinker, bar} is a key?
- We are given
  - drinker, bar, beer ⟶ season
  - drinker, bar ⟶ beer



Favorites(**drinker**, **bar**, beer, season)

Translating the Favorites relationship to a relation

- Can we reason that
  - drinker, bar ⟶ drinker, beer, bar, season?
  - And {drinker} or {bar} does not.
- If so, then we know {drinker, bar} is key!

Basic Rules: Armstrong's Axioms

- Reflexivity rule
  - If $B \subseteq A$, then $A \longrightarrow B$.
- Augmentation rule
  - If $A \longrightarrow B$, then $AC \longrightarrow BC$.
- Transitivity rule
  - If $A \longrightarrow B$ and $B \longrightarrow C$, then $A \longrightarrow C$.

Deriving More Rules

- Splitting rule
  - If $A \longrightarrow BC$, then $A \longrightarrow B$, and $A \longrightarrow C$.
  - Derivation
    - $\because A \longrightarrow BC$ and $BC \longrightarrow B$ (by reflexivity)
    - $\therefore A \longrightarrow B$ (by transitivity)
    - Similarly for $A \longrightarrow C$

- Combining rule
  - If $A \longrightarrow B$, and $A \longrightarrow C$, then $A \longrightarrow BC$.
  - Derivation
    - $\because A \longrightarrow AB$ (by augmentation) and $AB \longrightarrow BC$ (by augmentation)
    - $\therefore A \longrightarrow BC$ (by transitivity)

Reasoning: Is {drinker, bar} a Superkey?

- Suppose Favorites(drinker, bar, beer, season, price)
- **Given:**
  - **drinker, bar, beer ⟶ season**
  - **drinker, bar ⟶ beer**
  - **bar, beer ⟶ price**
- **Decide: Is {drinker, bar} a superkey?**

- To determine, can we reason:
- Is **drinker, bar ⟶ drinker, bar, beer, season, price** an FD?
- If it is an FD, then YES.

Reasoning: *Is* **drinker, bar ⟶ all** *an FD?*

- **Given:**
  - **drinker, bar, beer ⟶ season**
  - **drinker, bar ⟶ beer**
  - **bar, beer ⟶ price**
- **Decide: Is {drinker, bar} a Superkey?**

- 1. drinker, bar ⟶ drinker, bar (reflexivity)
- 2. drinker, bar ⟶ beer (given)
- 3. drinker, bar ⟶ season
  - drinker, bar ⟶ drinker, bar, beer (augmenting 2)
  - drinker, bar, beer ⟶ season (given)
  - drinker, bar ⟶ season (transitivity)
- 4. drinker, bar ⟶ price
  - How to derive?

- **5. drinker, bar ⟶ drinker, bar, beer, season, price** (combining all above)