

CS186 Discussion 11

(ER Diagrams, Functional Dependencies)

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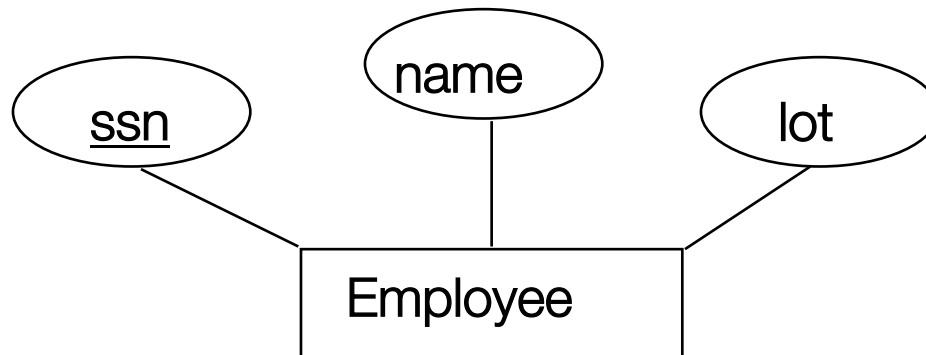
ER Diagrams

ER Diagrams

- Conceptual design of relations
 - Entities
 - Relationships
 - Attributes

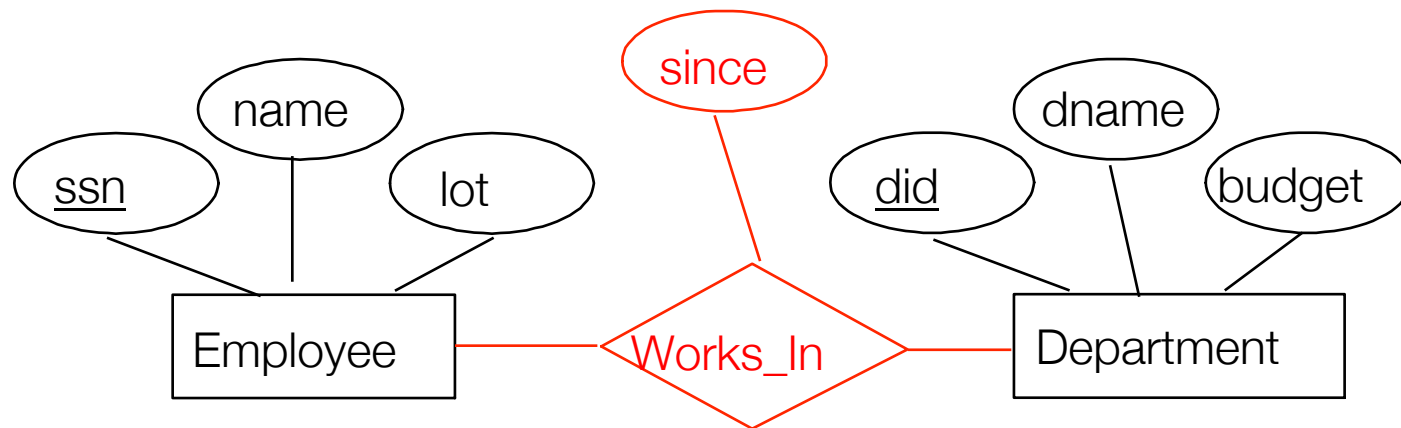
Entities

- Entity: a real world object described by a set of attributes
- Entity set: a collection of similar entities
 - E.g. all employees
 - Entities in entity set have same attributes
 - Has a key attribute
 - Each attribute has a domain



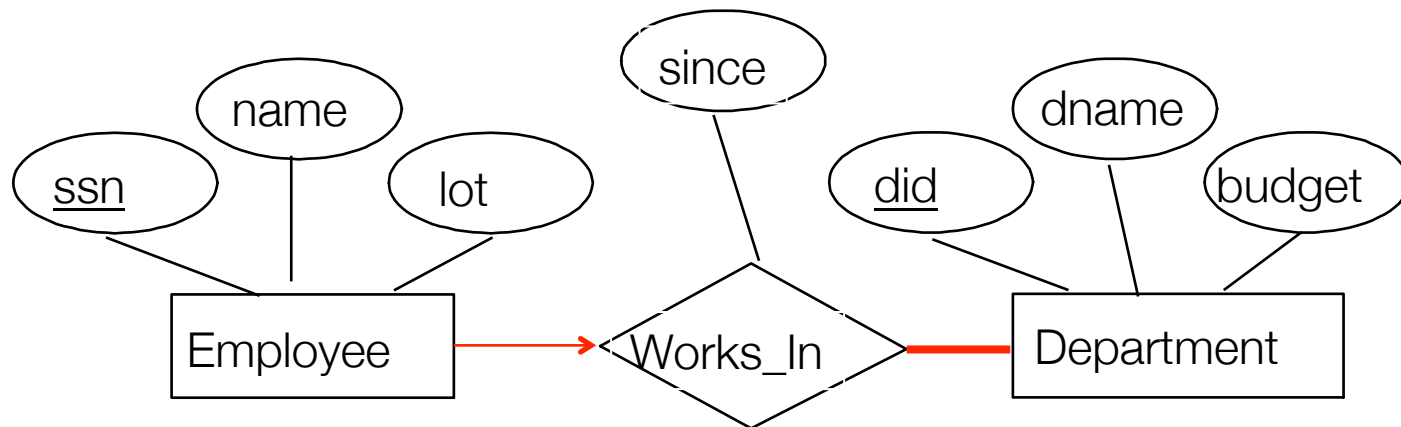
Relationships

- Relationship: association among two or more entities
 - Can have own attributes
- Relationship set: collection of similar relationships



Constraints

- Key constraint: entity participates at most once
 - Key, non-key
 - Represented by \longrightarrow
- Participation constraint: entity participates at least once
 - Total, partial
 - Represented by —



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	Partial Participation	Total Participation
Non-Key	0 or more ——	1 or more ——
Key	0 or 1 \longrightarrow	1 \longrightarrow

Ternary Relations

- 3 entities connected to a relationship instead of 2

Weak Entity

- An entity that only makes sense in the context of another entity (its parent)
 - Has a partial key (dashed underline)
- E.g. there can be two songs with the same name
 - Key is (Artists.artist_id, Songs.song_name)

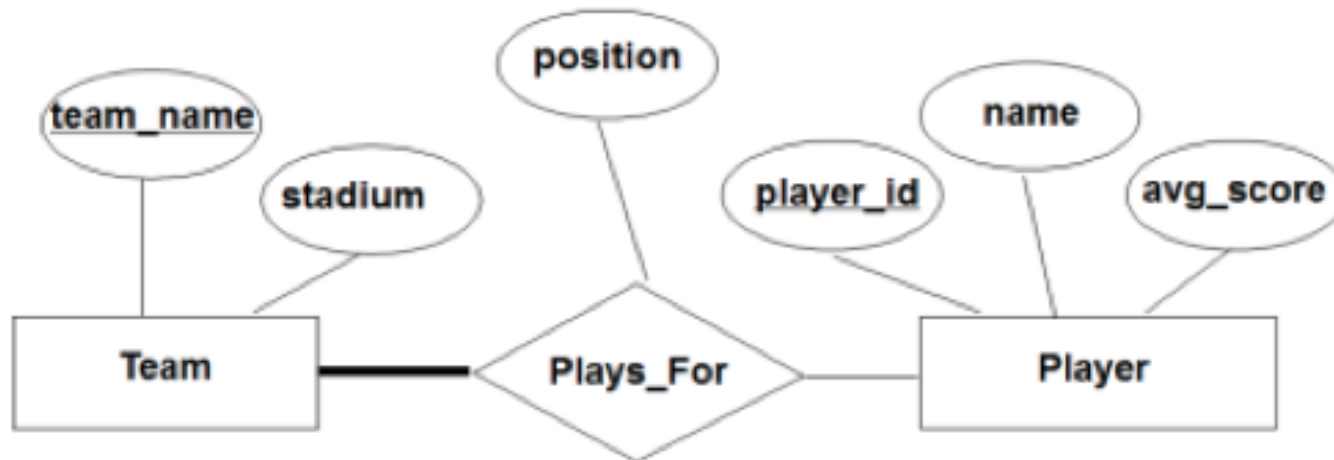
ER Diagram Exercises

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1. Assume that a player can play in more than one team (Yes, our league has different rules!) and that a team needs at least one player. Draw an ER diagram for our database.

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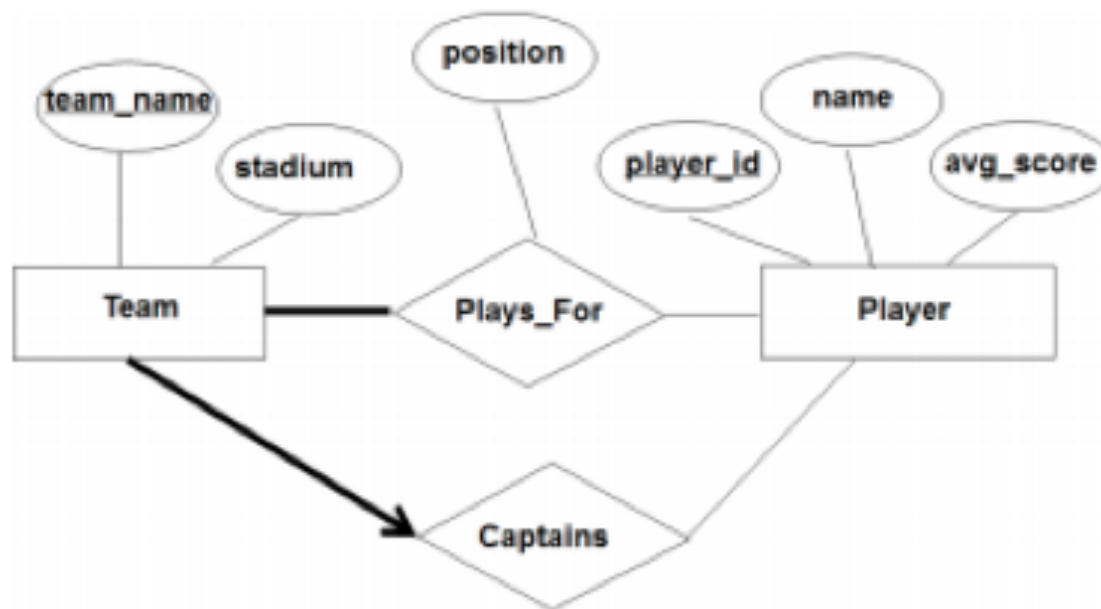


ER Diagrams Exercises

2. Now let's say we want to also track who is the captain of every team. How will the ER diagram change from the previous case? Note: Every team needs exactly one captain!

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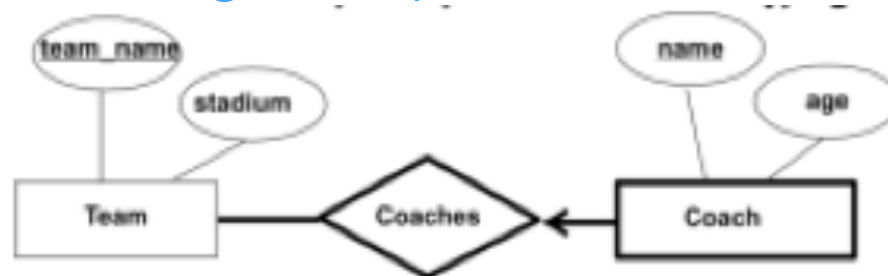
ER Diagrams Exercises

3. Are there any weak-entity relationships in either of our ER diagrams?

ER Diagrams Exercises

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No. A weak entity can be identified uniquely only by considering the primary key of another (owner) entity. Consider the following example:



A team can have many coaches, but each coach exactly coaches one team. Coach is a weak-entity set and can be identified by its partial key “name”.

Functional Dependencies

Functional Dependencies

- Used to identify redundancy in schemas and suggest refinement
- $X \rightarrow Y$
 - X determines Y
- $K \rightarrow \{\text{all attributes of } R\}$
 - K is a superkey of R

Armstrong's Axioms

- **Reflexivity:** If $X \supseteq Y$, then $X \rightarrow Y$
- **Augmentation:** If $X \rightarrow Y$, then $XZ \rightarrow YZ$ for any Z
 - $XZ \rightarrow YZ$ does not mean $X \rightarrow Y$
- **Transitivity:** If $X \rightarrow Y$ and $Y \rightarrow Z$, then $X \rightarrow Z$
- **Union:** If $X \rightarrow Y$ and $X \rightarrow Z$, then $X \rightarrow YZ$
- **Decomposition:** If $X \rightarrow YZ$, then $X \rightarrow Y$ and $X \rightarrow Z$

Closures

- X^+ : set of all FDs implied by X , including trivial dependencies

```
 $X^+ := X$ 
```

```
while not done:
```

```
    for  $U \rightarrow V$  in  $F$ :
```

```
        if  $U$  in  $X^+$ :
```

```
            add  $V$  to  $X^+$ 
```

Boyce-Codd Normal Form (BCNF)

- R is in BCNF if the only non-trivial FDs over R are key constraints
- R with FDs F is in BCNF if
for all $X \rightarrow A$ in F^+ :
 - $A \subseteq X$ (called a trivial FD), or
 - X is a superkey for R

BCNF Decomposition

- For R , if $X \rightarrow A$ violates BCNF, decompose R into $R - A$ and XA

Functional Dependencies Exercises

Functional Dependencies Exercises

1. Flight schema

Flights(**F**light_no, **D**ate, **fR**om, **T**o, **P**lane_id),
ForeignKey(**P**lane_id)

Planes(**P**lane_id, **tY**pe)

Seat(**S**eat_no, **P**lane_id, **L**egroom), ForeignKey(**P**lane_id)

Find the set of functional dependencies.

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Find the set of functional dependencies.

FD \rightarrow RTP

P \rightarrow Y

SP \rightarrow L

Functional Dependencies Exercises

2. Now consider the attribute set $R = ABCDE$ and the FD set $F = \{AB \rightarrow C, A \rightarrow D, D \rightarrow E, AC \rightarrow B\}$. Compute the closure for the following attributes.

A:

AB:

B:

D:

Functional Dependencies Exercises

2. Now consider the attribute set $R = ABCDE$ and the FD set $F = \{AB \rightarrow C, A \rightarrow D, D \rightarrow E, AC \rightarrow B\}$. Compute the closure for the following attributes.

A: $\{A, D, E\}$

AB: $\{A, B, C, D, E\}$

B: $\{B\}$

D: $\{D, E\}$

Functional Dependencies Exercises

3. Decompose $R = ABCDEFG$ into BCNF, given the functional dependency set:

$$F = \{AB \rightarrow CD, C \rightarrow EF, G \rightarrow A, G \rightarrow F, CE \rightarrow F\}$$

Functional Dependencies Exercises

3. Decompose $R = ABCDEFG$ into BCNF, given the functional dependency set:

$F = \{AB \rightarrow CD, C \rightarrow EF, G \rightarrow A, G \rightarrow F, CE \rightarrow F\}$

$AB \rightarrow CD \Rightarrow$ decompose $ABCDEFG$ into $ABCD$, $ABEFG$

$G \rightarrow A \Rightarrow$ decompose $ABEFG$ into AG , $BEFG$

$G \rightarrow F \Rightarrow$ decompose $BEFG$ into FG , BEG

Final relations: $ABCD$, AG , FG , BEG .

Functional Dependencies Exercises

4. Does the above decomposition preserve dependencies?

$F = \{AB \rightarrow CD, C \rightarrow EF, G \rightarrow A, G \rightarrow F, CE \rightarrow F\}$

Final relations: ABCD, AG, FG, BEG

Functional Dependencies Exercises

4. Does the above decomposition preserve dependencies?

$F = \{AB \rightarrow CD, C \rightarrow EF, G \rightarrow A, G \rightarrow F, CE \rightarrow F\}$

Final relations: ABCD, AG, FG, BEG

No, $C \rightarrow EF$ and $CE \rightarrow F$ are not represented in the closure of the union of each subrelation's dependencies