CMU SCS

Carnegie Mellon Univ.
Dept. of Computer Science
15-415 - Database Applications

Lecture#3: E-R diagrams

CMU SCS

Database Design

- Requirements Analysis
- Conceptual Design
- Logical Design
- Schema Refinement
- Physical Design
- Security Design

CMU SCS

Database Design

- Requirements Analysis — user's needs
- **Conceptual Design** — high level (ER)
- Logical Design — Tables
- Schema Refinement — Normalization
- Physical Design — Indices etc
- Security Design — Access controls

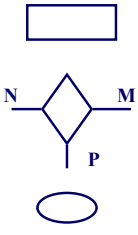
CMU SCS

Overview

- concepts
  - Entities
  - Relationships
  - Attributes
  - Specialization/Generalization
  - Aggregation
  - ER modeling questions

CMU SCS

Tools



Entities ('entity sets')

Relationships ('rel. sets')

and mapping constraints

attributes

CMU SCS

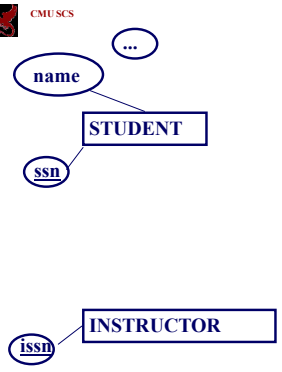
Example

Students, taking courses, offered by instructors; a course may have multiple sections; one instructor per section

nouns -> entity sets

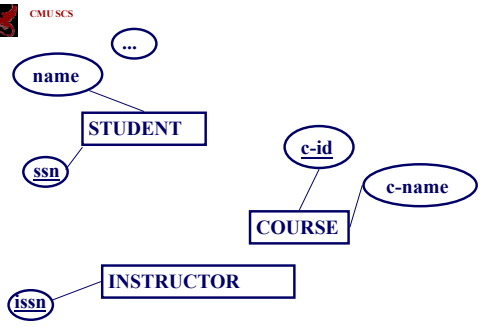
verbs -> relationship sets

CMU SCS



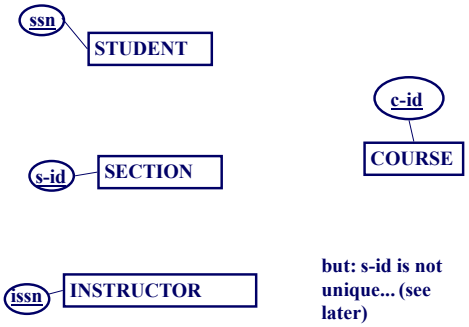
primary key =
unique identifier ->
underline

CMU SCS



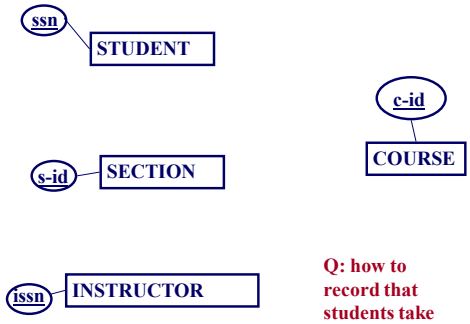
but: sections of course (with different instructors)?

CMU SCS



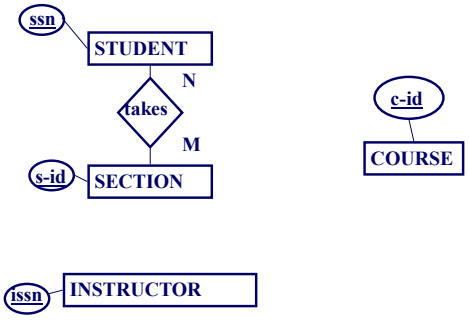
but: s-id is not unique... (see later)

CMU SCS

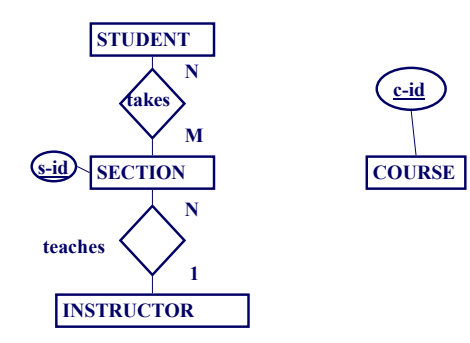


Q: how to record that students take courses?

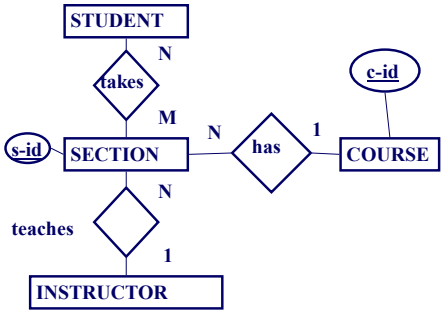
CMU SCS



CMU SCS



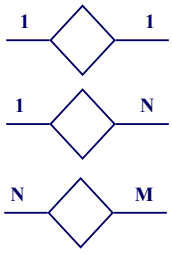
CMU SCS



CMU SCS

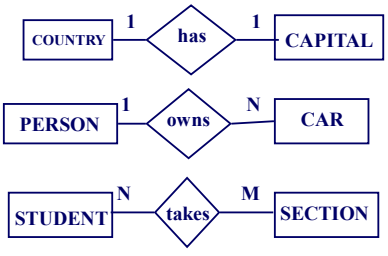
Cardinalities

- 1 to 1 (example?)
- 1 to N
- N to M



CMU SCS

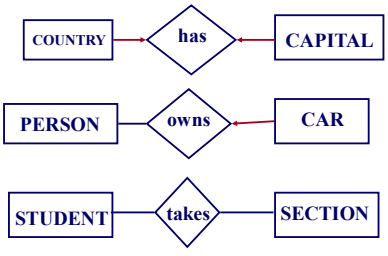
Cardinalities



CMU SCS

Cardinalities

Book's notation:



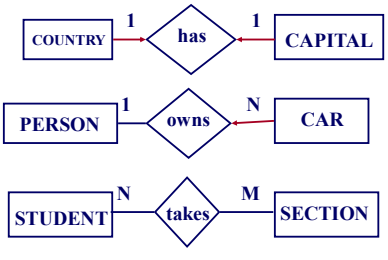
CMU SCS

Cardinalities

Book's notation

vs

***1 to N* notation**



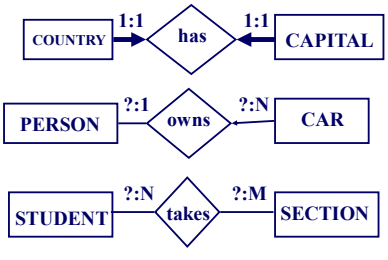
CMU SCS

'Total/partial' participation

total, total

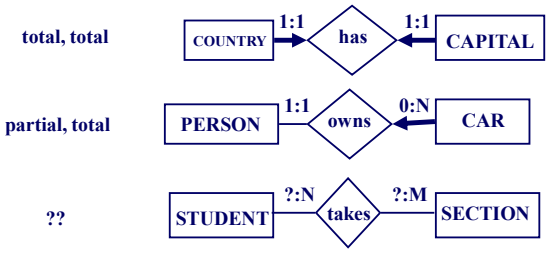
??

??



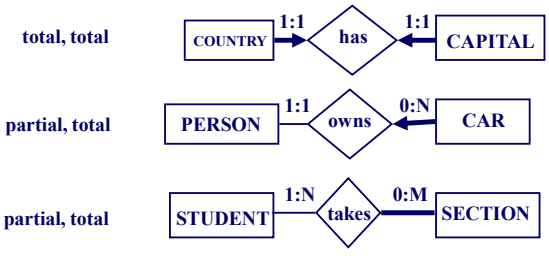
CMU SCS

'Total/partial' participation



CMU SCS

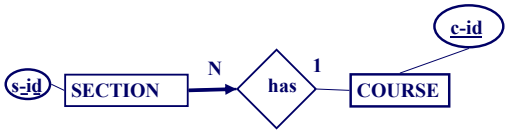
'Total/partial' participation



CMU SCS

Weak entities

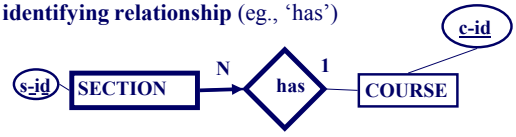
- 'section' has no unique-id of its own!(?)



CMU SCS

Weak entities

- '**weak**' entities: if they need to borrow a unique id from a 'strong entity - **thick** box.
- 'c-id' + 's-id': unique id for SECTION
- **partial key** (eg., 's-id') - dashed-underline
- **identifying relationship** (eg., 'has')



CMU SCS

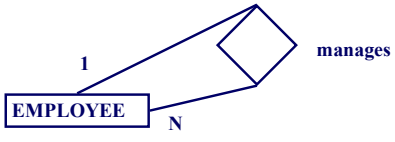
More details

- self-relationships - example?

CMU SCS

More details

- self-relationships - example?



CMU SCS

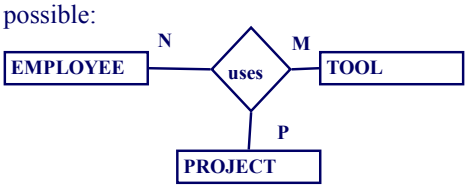
More details

- 3-way and k-way relationships?

CMU SCS

More details

- 3-way and k-way relationships? Rare, but possible:



CMU SCS

Overview

- concepts
  - Entities
  - Relationships
  - Attributes
  - Specialization/Generalization
  - Aggregation
  - ER modeling questions

CMU SCS

More details - attributes

- **key** (or **primary key**): unique identifier
- underlined, in the ER diagram
- [not in textbook - FYI:
  - **multivalued** or set-valued attributes (eg., 'dependents' for EMPLOYEE)
  - **derived** attributes (eg., 15% tip)

  ]

CMU SCS

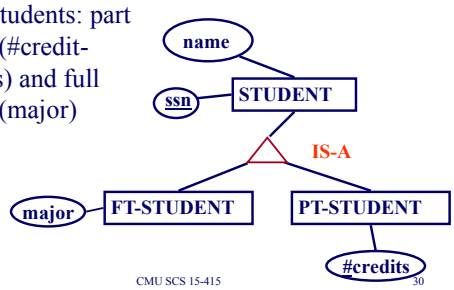
Overview

- concepts
  - Entities
  - Relationships
  - Attributes
  - Specialization/Generalization
  - Aggregation
  - ER modeling questions

CMU SCS

Specialization

- eg., students: part time (#credit-hours) and full time (major)



CMU SCS

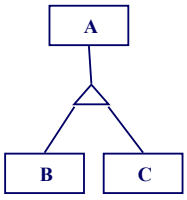
Observations

- Generalization: exact reverse of 'specialization'
- attribute inheritance
- could have **many** levels of an IS-A hierarchy

CMU SCS

More details

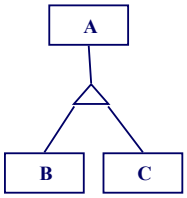
- Overlap constraints
- Covering constraints



CMU SCS

More details

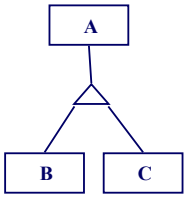
- Overlap constraints
  - can an entity belong to both 'B' and 'C'?
- Covering constraints
  - can an 'A' entity belong to neither 'B' nor 'C'?



CMU SCS

More details

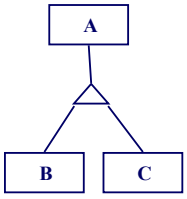
- Overlap constraints - examples?



CMU SCS

More details

- Covering constraints - examples?



CMU SCS

Overview

- concepts
  - Entities
  - Relationships
  - Attributes
  - Specialization/Generalization
  - Aggregation
  - ER modeling questions

CMU SCS

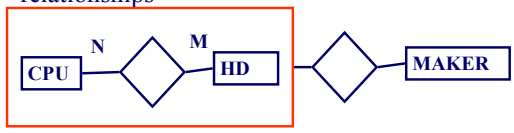
Aggregation

- computer model (w/ CPU and HD)
- and Maker (eg., Dell, HP)

CMU SCS

Aggregation

- treat a relationship as an entity
- used to express a relationship among relationships



CMU SCS

Overview

- concepts
  - Entities
  - Relationships
  - Attributes
  - Specialization/Generalization
  - Aggregation
  - ER modeling questions

CMU SCS

Conceptual design

- Entity vs attribute
- Entity vs relationship
- Binary or ternary relationships?
- Aggregation?

CMU SCS

Entity vs. attribute

- Entity EMPLOYEE (w/ emp#, name, job_code, ...)
- Q: How about ‘spouse’ - entity or attribute?
- Q: How about ‘dependents’?

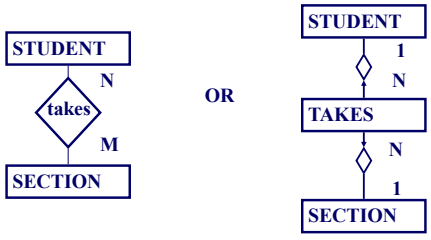
CMU SCS

Entity vs. attribute

- Entity EMPLOYEE (w/ emp#, name, job_code, ...)
- Q: How about ‘spouse’ - entity or attribute?
- A: probably, ‘attribute’ is enough
- Q: How about ‘dependents’?
- A: Entity - we may have many dependents

CMU SCS

Entity vs. Relationship



CMU SCS

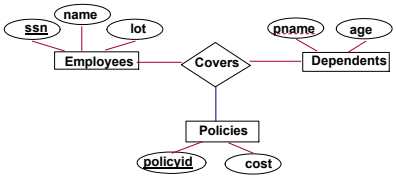
Binary vs Ternary Relationships

- usually, binary relationships are 'cleaner':

CMU SCS

Binary vs. Ternary Relationships

If each policy is owned by just 1 employee:

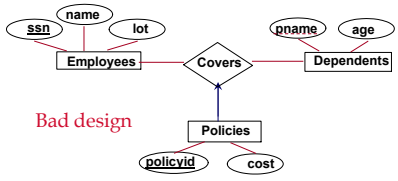


CMU SCS

Binary vs. Ternary Relationships

If each policy is owned by just 1 employee:

Bad design

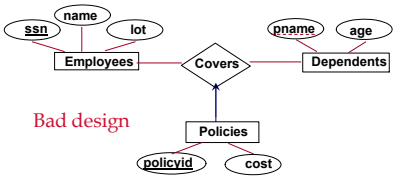


CMU SCS

Binary vs. Ternary Relationships

If each policy is owned by just 1 employee:

Bad design



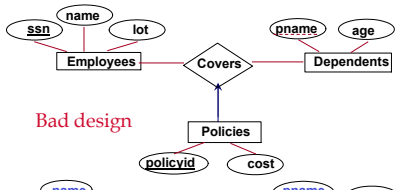
Key constraint on Policies would mean policy can only cover 1 dependent!

CMU SCS

Binary vs. Ternary Relationships

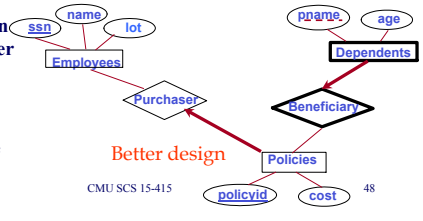
If each policy is owned by just 1 employee:

Bad design



Key constraint on Policies would mean policy can only cover 1 dependent!

What are the additional constraints in the 2nd diagram?



Better design

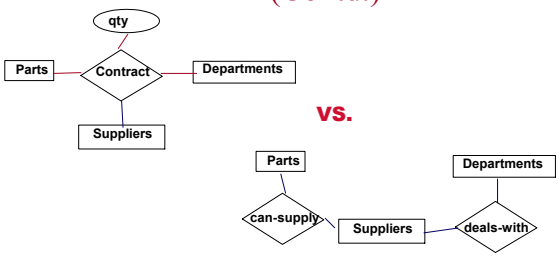
CMU SCS

Binary vs Ternary Rel.

- But sometimes ternary rel. can not be replaced by a set of binary rel's:

CMU SCS

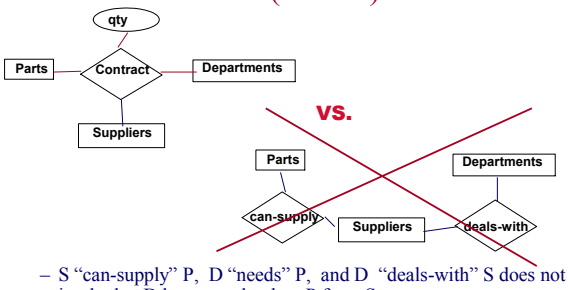
Binary vs. Ternary Relationships (Contd.)



why is it bad?

CMU SCS

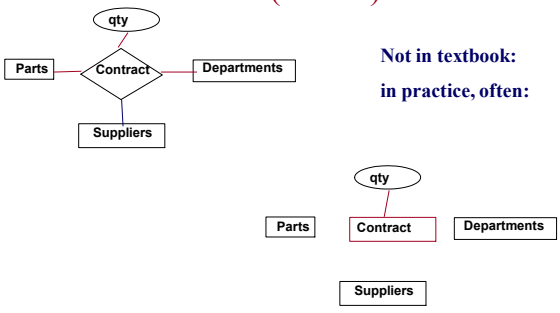
Binary vs. Ternary Relationships (Contd.)



- S "can-supply" P, D "needs" P, and D "deals-with" S does not imply that D has agreed to buy P from S.
- How do we record *qty*?

CMU SCS

Binary vs. Ternary Relationships (Contd.)

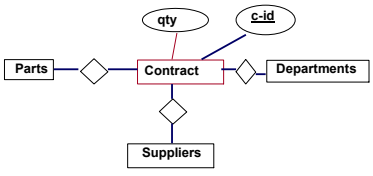


CMU SCS

Binary vs. Ternary Relationships (Contd.)

Not in textbook:

in practice, often:



CMU SCS

Ternary vs. aggregation

- use aggregation, if we want to attach a relationship to a relationship
- (see book for example)
- (in practice, again we create a unique-id and resort to binary relationships)

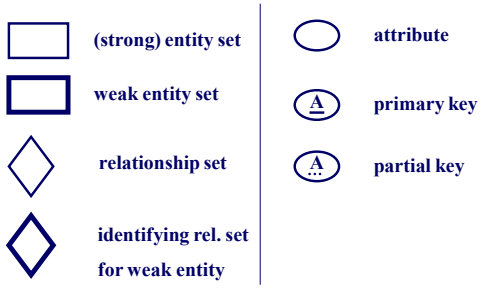
CMU SCS

Summary

- E-R Diagrams: a powerful, user-friendly tool for data modeling:
  - Entities (strong, weak)
  - Attributes (primary keys, discriminators, derived, multivalued)
  - Relationships (1:1, 1:N, N:M; multi-way)
  - Generalization/Specialization; Aggregation

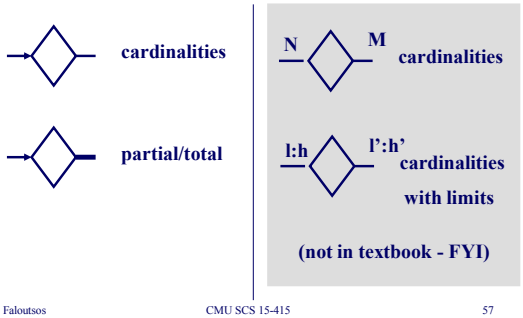
CMU SCS

Summary - cont'd



CMU SCS

Summary - cont'd



CMU SCS

Summary - cont'd