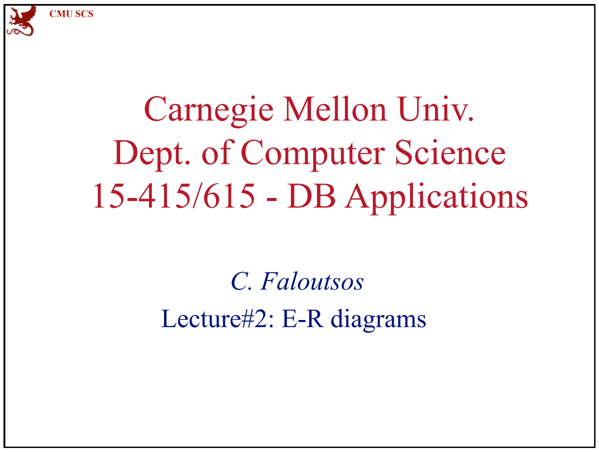
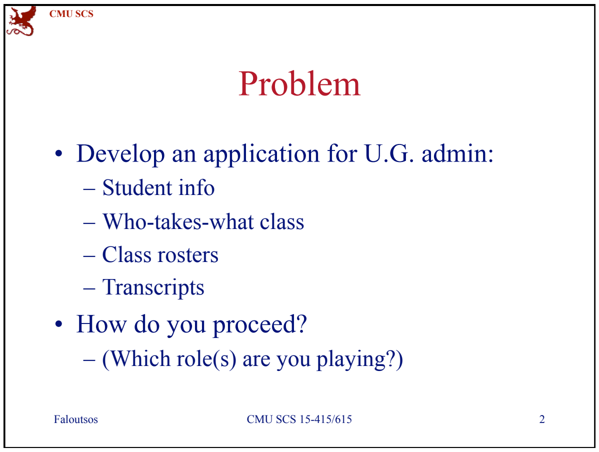


CMU SCS

Carnegie Mellon Univ.
Dept. of Computer Science
15-415/615 - DB Applications

C. Faloutsos

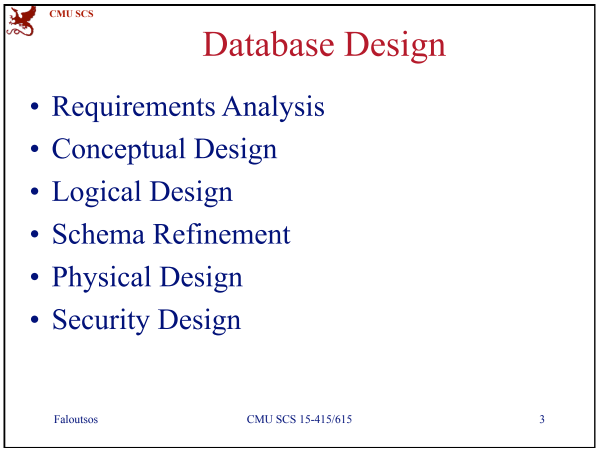
Lecture#2: E-R diagrams



CMU SCS

Problem

- Develop an application for U.G. admin:
  - Student info
  - Who-takes-what class
  - Class rosters
  - Transcripts
- How do you proceed?
  - (Which role(s) are you playing?)



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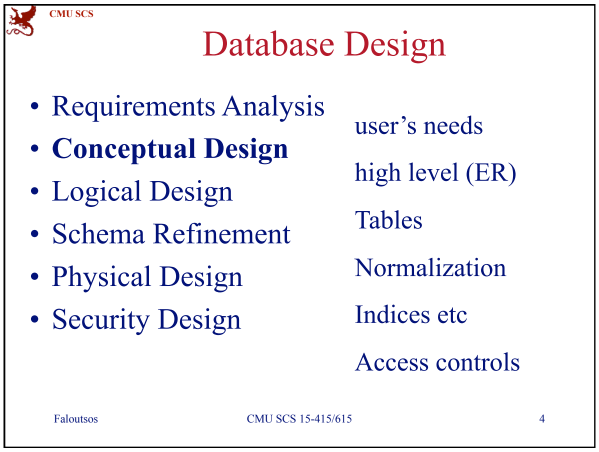
Database Design

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



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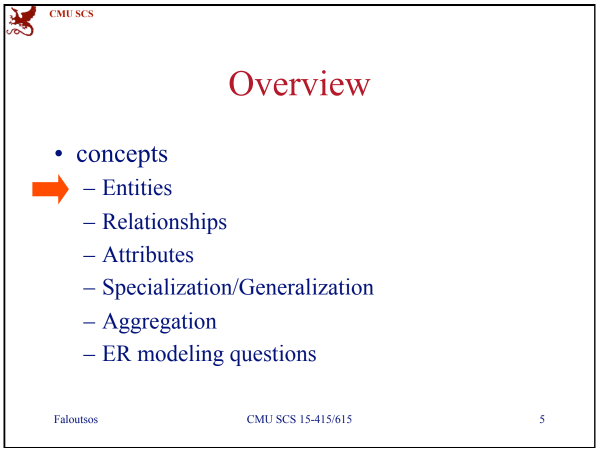
Database Design

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



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Overview

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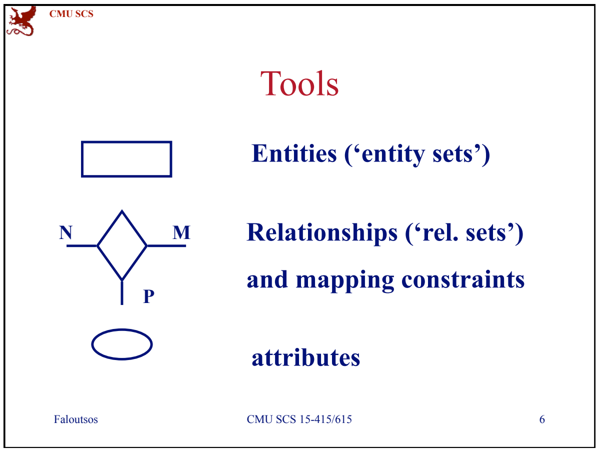
  - ER modeling questions



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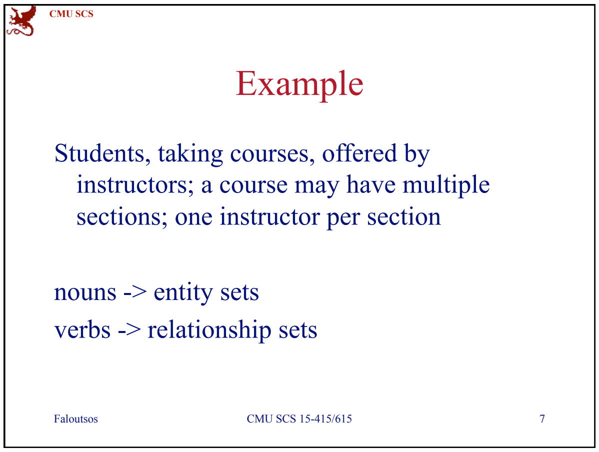
Tools

Entities ('entity sets')

Relationships ('rel. sets') and mapping constraints

attributes



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Example

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

nouns -> entity sets

verbs -> relationship sets

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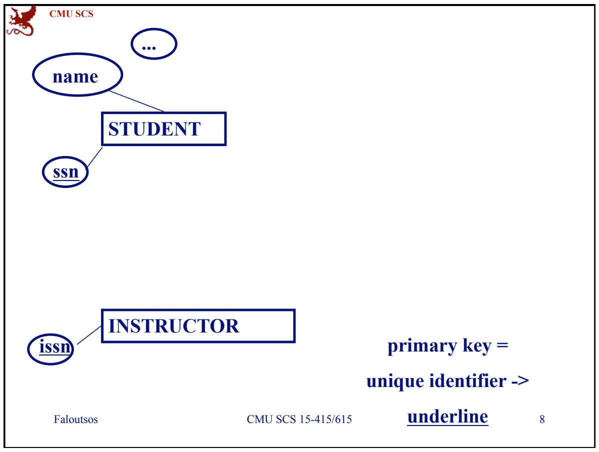

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primary key =

unique identifier ->

underline

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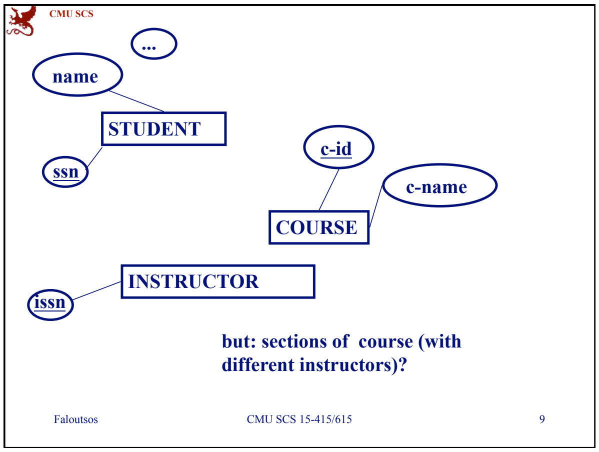

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but: sections of course (with different instructors)?

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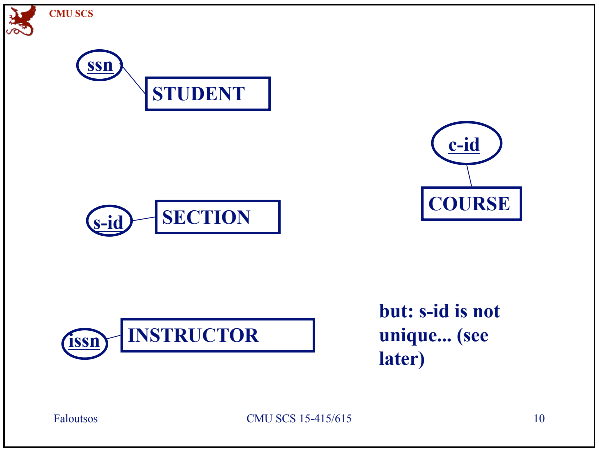


CMU SCS

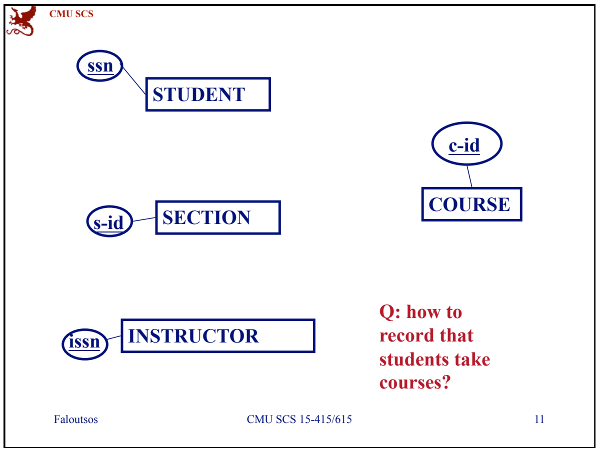
ssn
STUDENT

c-id
COURSE

s-id
SECTION

issn
INSTRUCTOR

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



CMU SCS

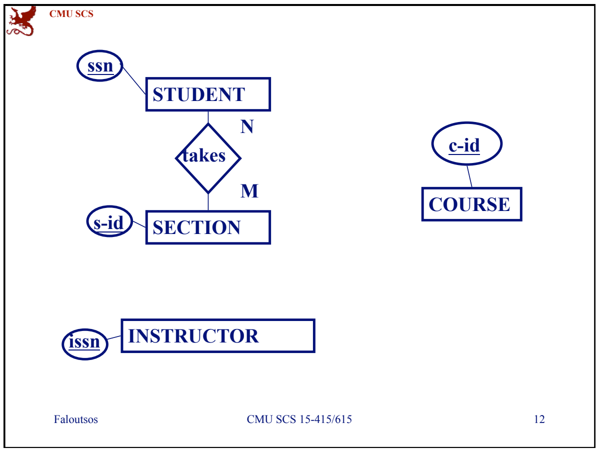
ssn
STUDENT

c-id
COURSE

s-id
SECTION

issn
INSTRUCTOR

Q: how to record that students take courses?

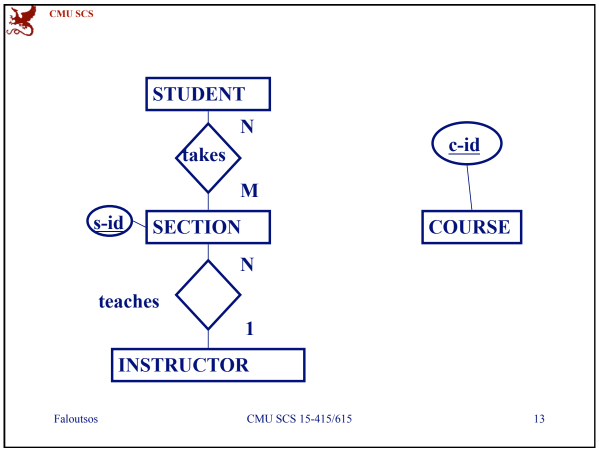


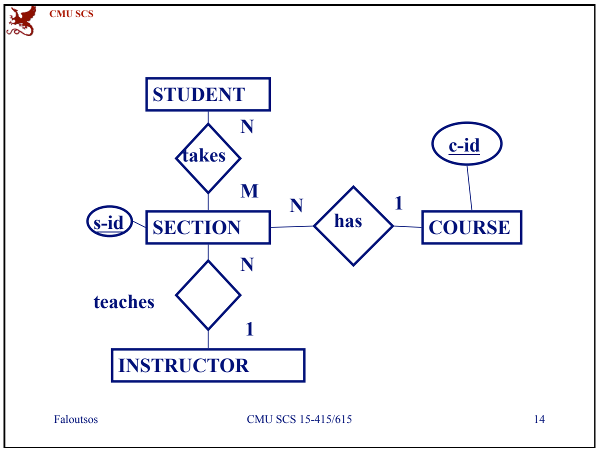
CMU SCS

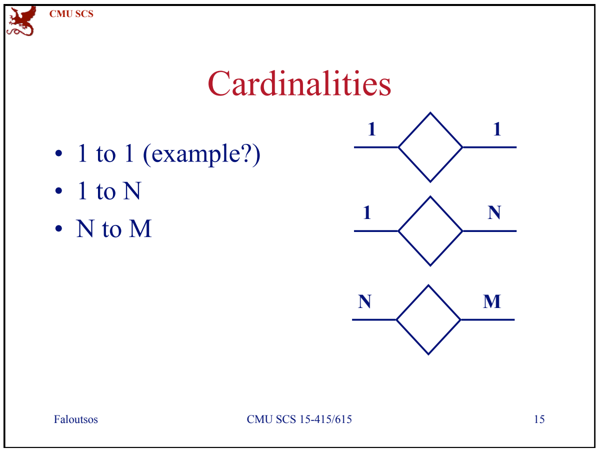
ssn
STUDENT
N
takes
M
s-id
SECTION

c-id
COURSE

issn
INSTRUCTOR







Cardinalities

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

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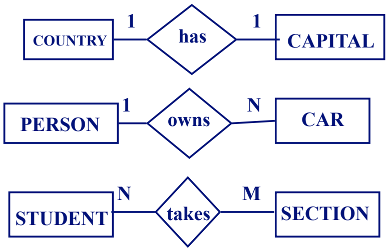
Cardinalities



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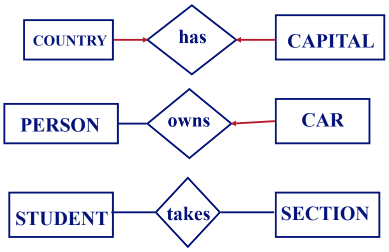
Cardinalities

Book's notation:



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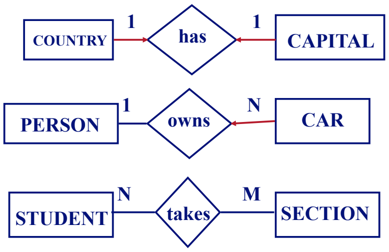
Cardinalities

Book's notation

vs

***1 to N* notation**



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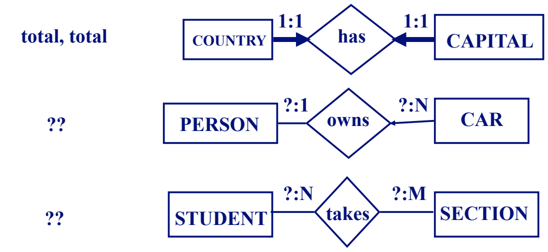
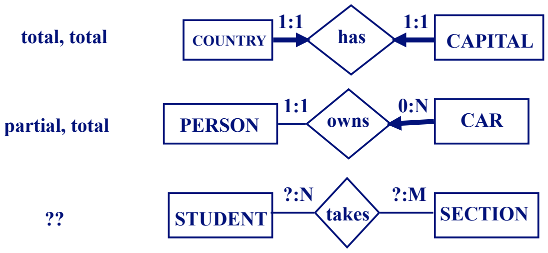
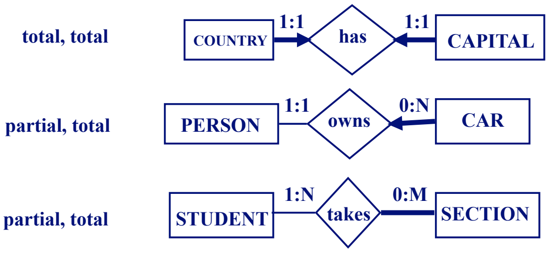
‘Total/partial’ participation

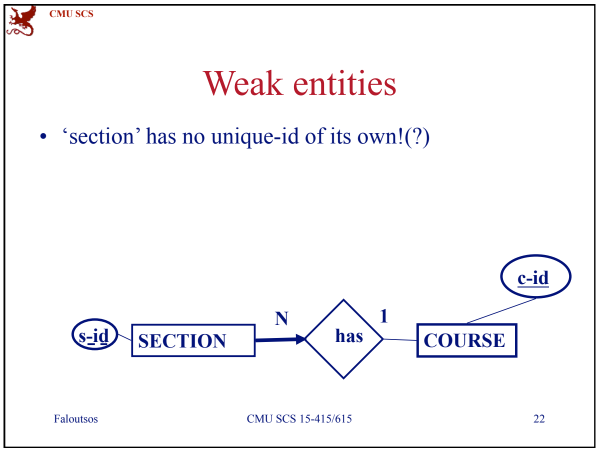


‘Total/partial’ participation



‘Total/partial’ participation





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Weak entities

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

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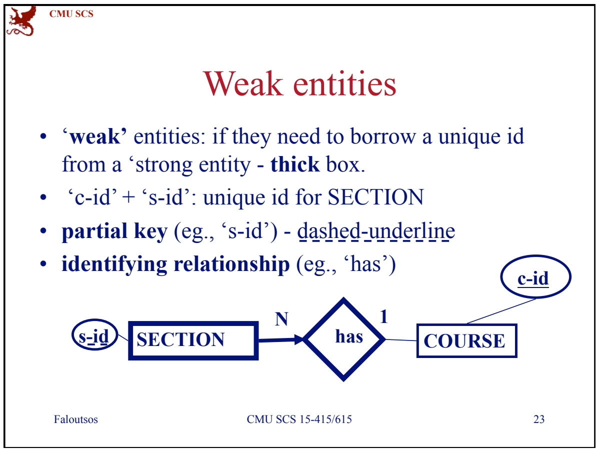

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Weak entities

- '**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')

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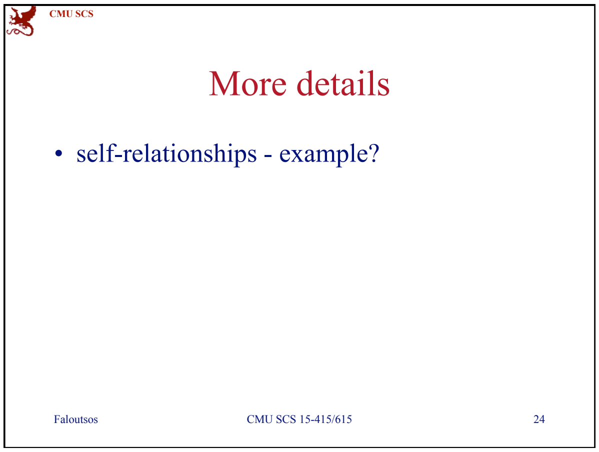

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More details

- self-relationships - example?

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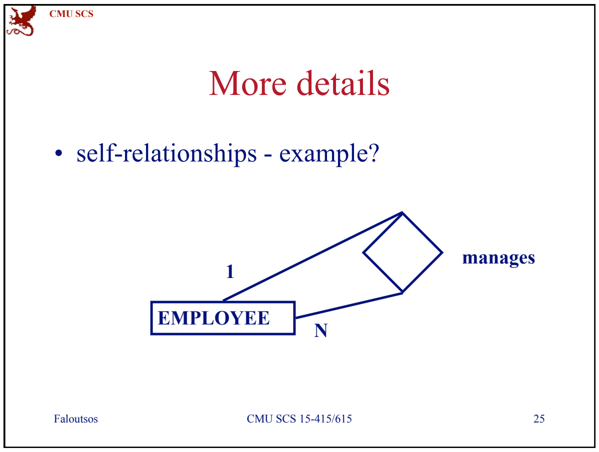
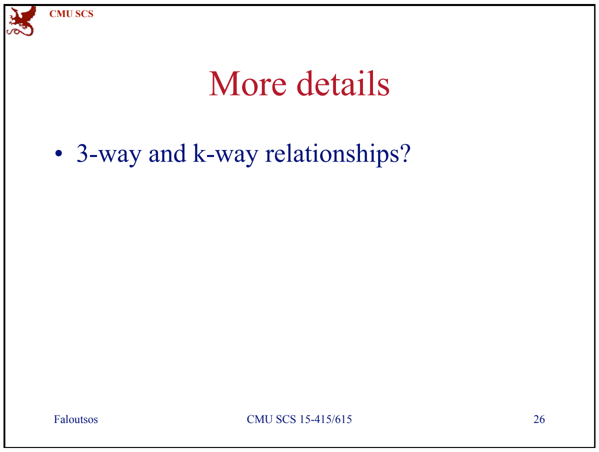


CMU SCS

More details

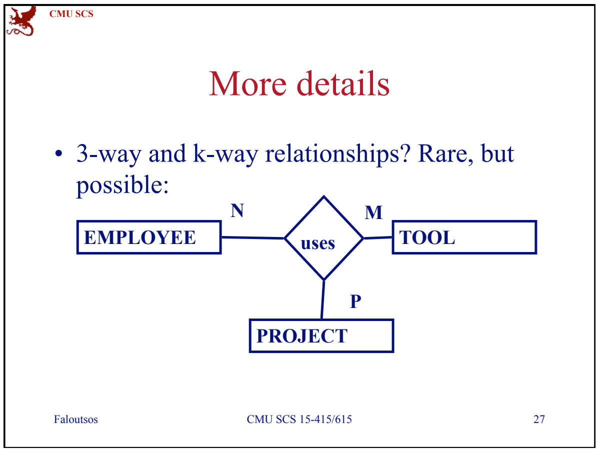
- self-relationships - example?



CMU SCS

More details

- 3-way and k-way relationships?



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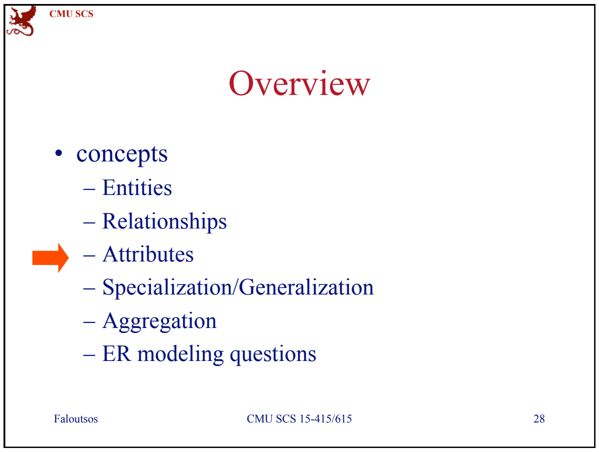
More details

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



Overview

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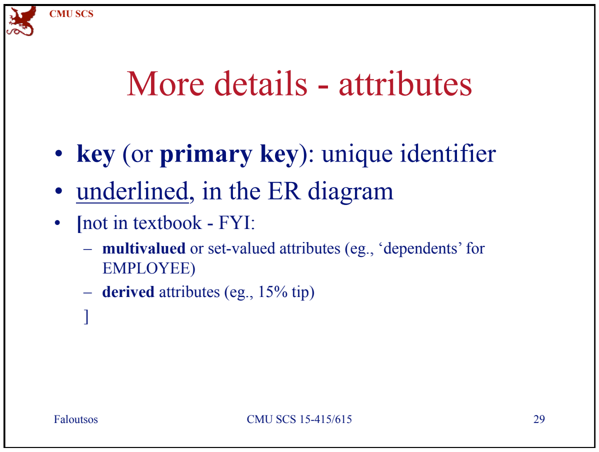
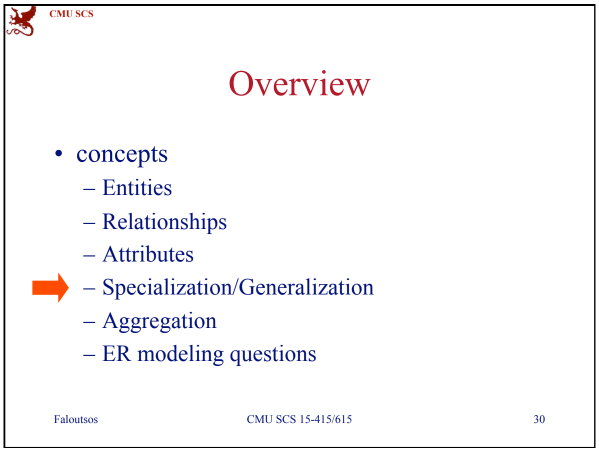
  - ➡ Attributes
  - Specialization/Generalization
  - Aggregation
  - ER modeling questions



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)

  ]



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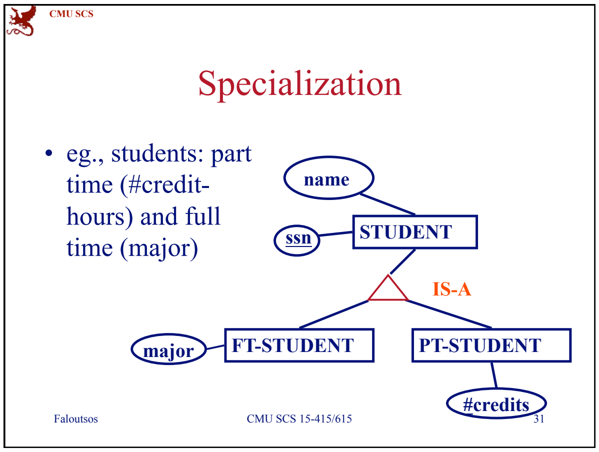

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Specialization

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

name

ssn

STUDENT

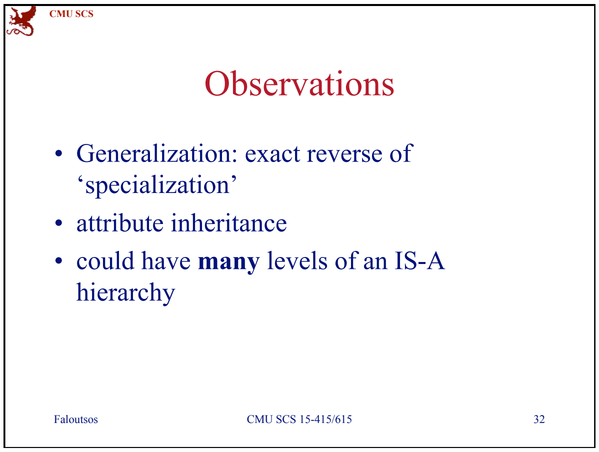
IS-A

major

FT-STUDENT

PT-STUDENT

#credits



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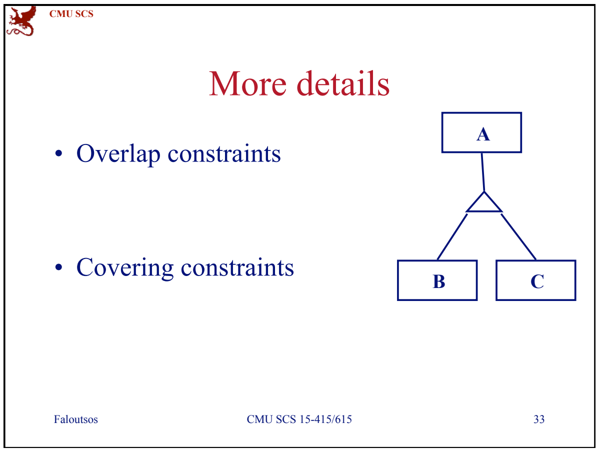
Observations

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



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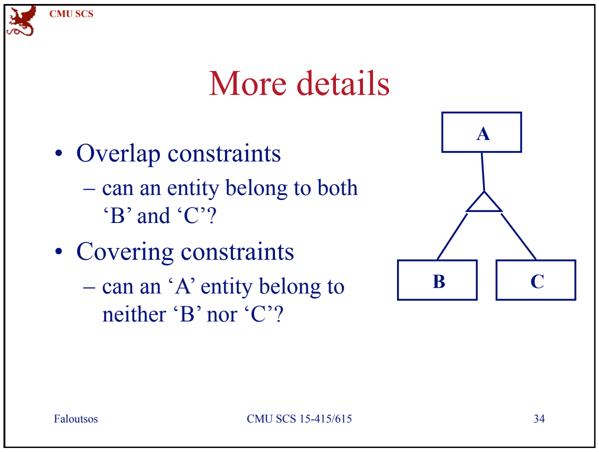
More details

- Overlap constraints
- Covering constraints

A

B

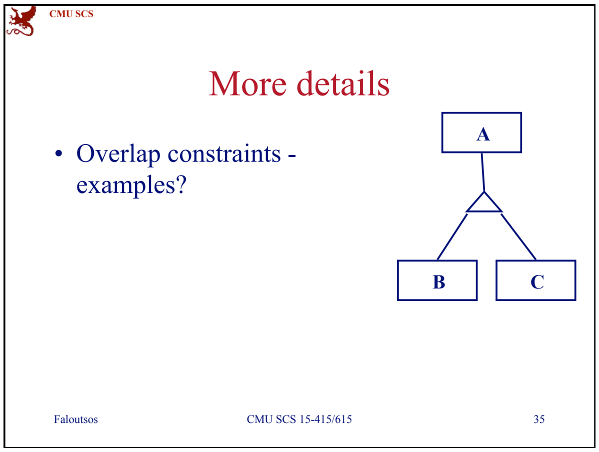
C



CMU SCS

More details

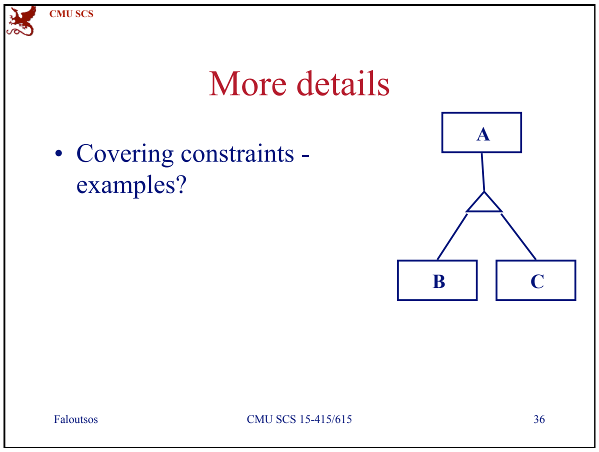
- Overlap constraints
  - can an entity belong to both ‘B’ and ‘C’?
- Covering constraints
  - can an ‘A’ entity belong to neither ‘B’ nor ‘C’?



CMU SCS

More details

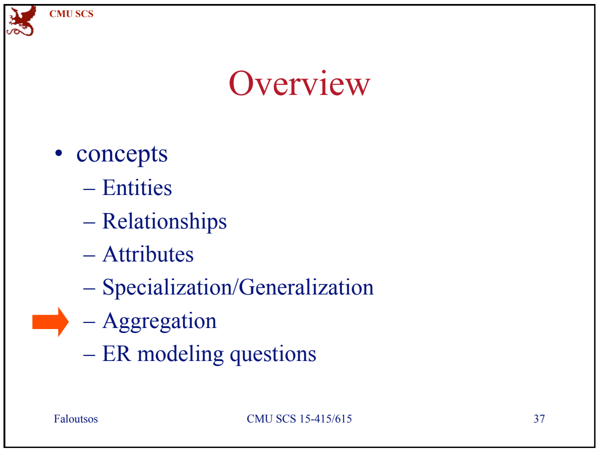
- Overlap constraints - examples?



CMU SCS

More details

- Covering constraints - examples?



CMU SCS

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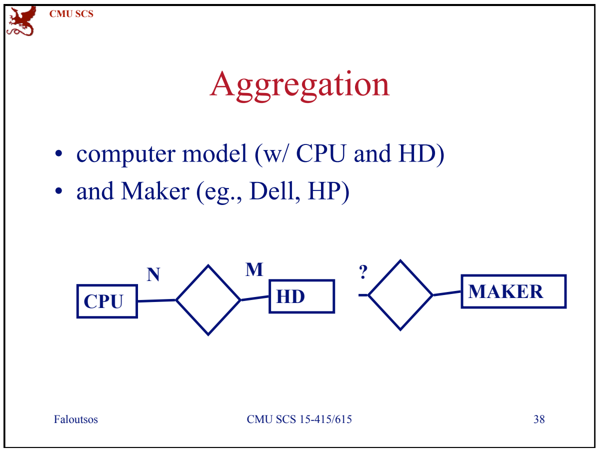

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Aggregation

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

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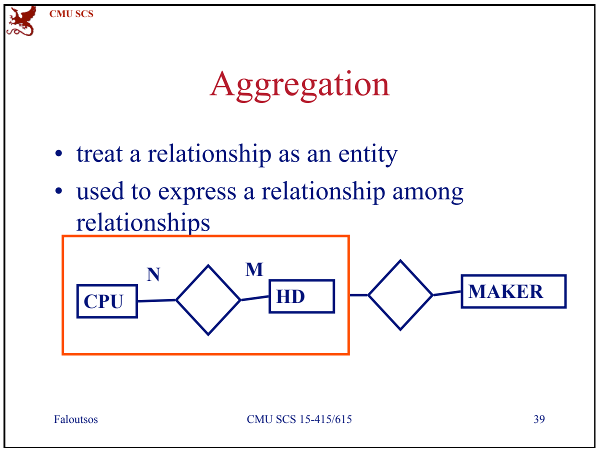

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Aggregation

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

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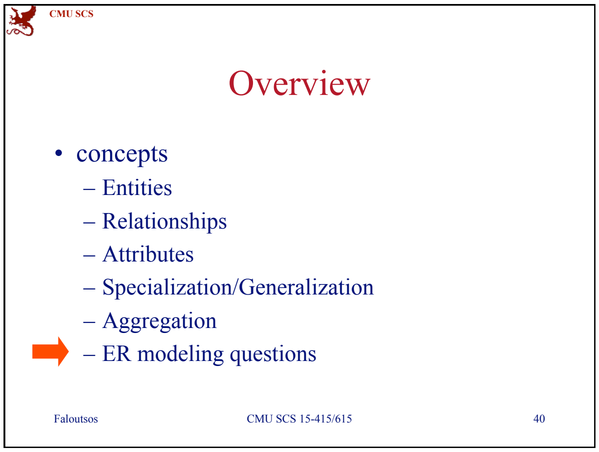

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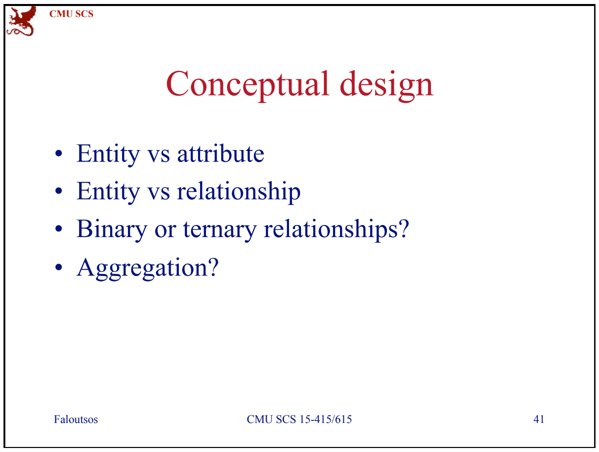
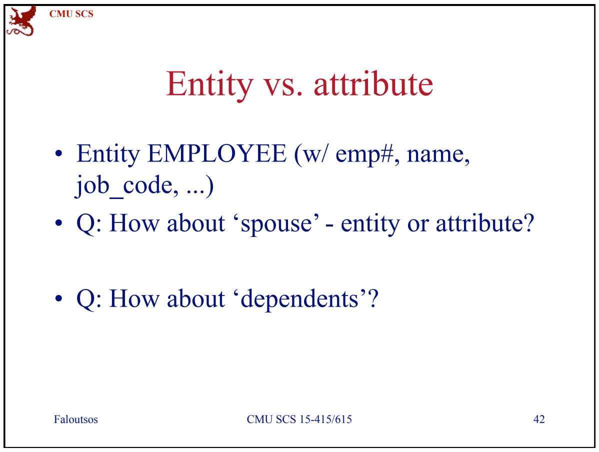


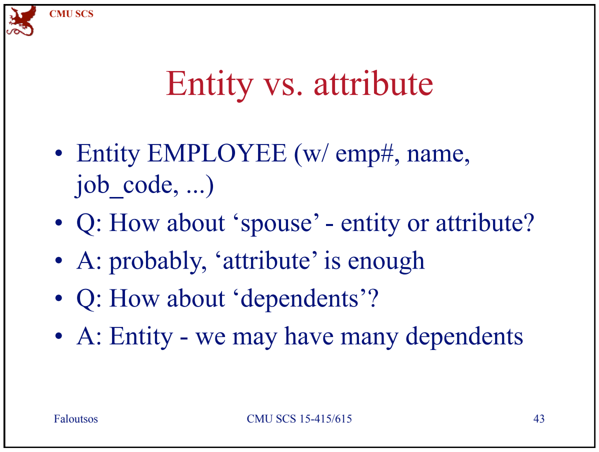
Conceptual design

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



Entity vs. attribute

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



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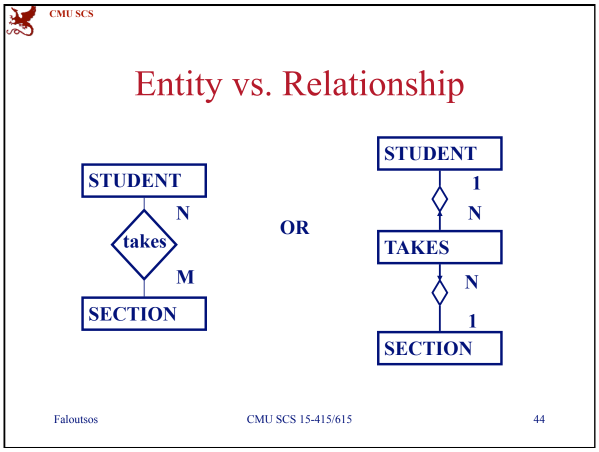
Entity vs. attribute

- 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



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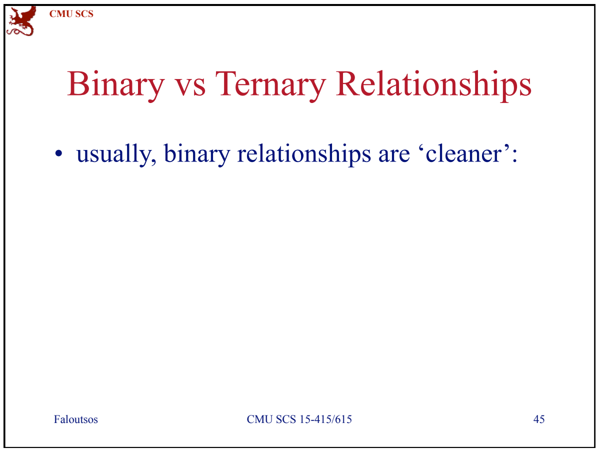
Entity vs. Relationship

STUDENT
N
takes
M
SECTION

OR

STUDENT
1
N
TAKES
N
1
SECTION



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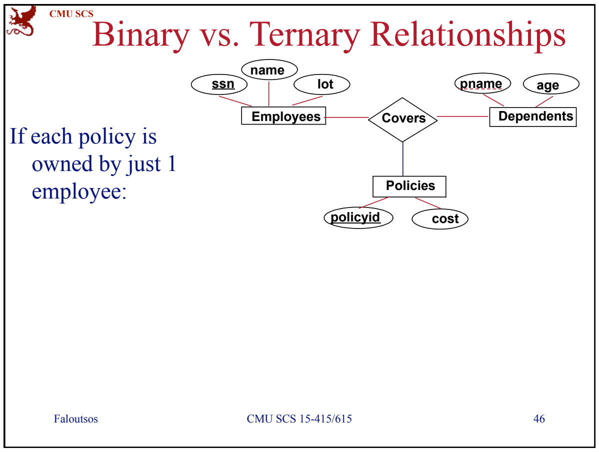
Binary vs Ternary Relationships

- usually, binary relationships are 'cleaner':



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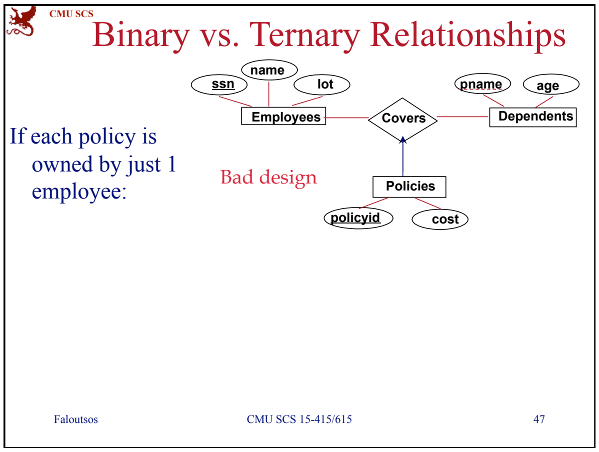
Binary vs. Ternary Relationships

If each policy is owned by just 1 employee:

ssn
name
lot
Employees
Covers
pname
age
Dependents
Policies
policyid
cost



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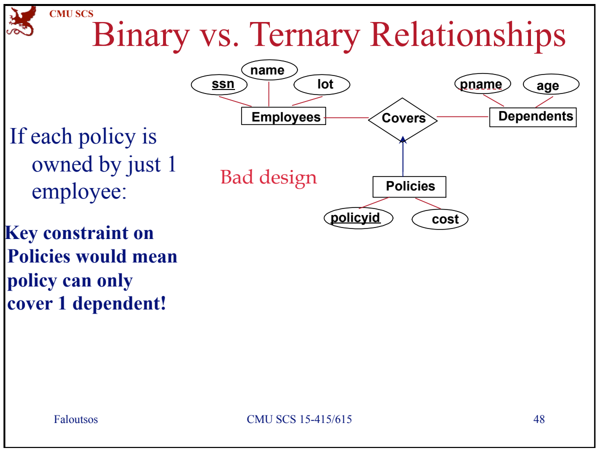
Binary vs. Ternary Relationships

If each policy is owned by just 1 employee:

Bad design

ssn
name
lot
Employees
Covers
pname
age
Dependents
Policies
policyid
cost



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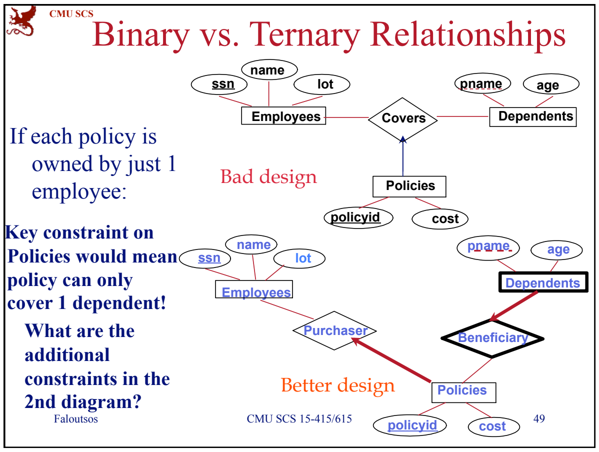
Binary vs. Ternary Relationships

If each policy is owned by just 1 employee:

Bad design

ssn
name
lot
Employees
Covers
pname
age
Dependents
Policies
policyid
cost

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



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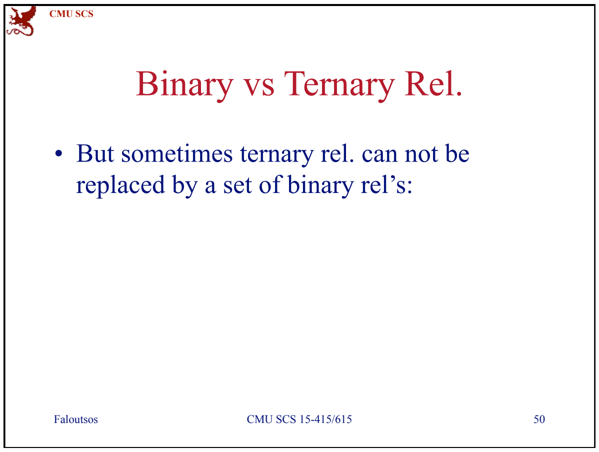
Binary vs. Ternary Relationships

If each policy is owned by just 1 employee:

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

What are the additional constraints in the 2nd diagram?



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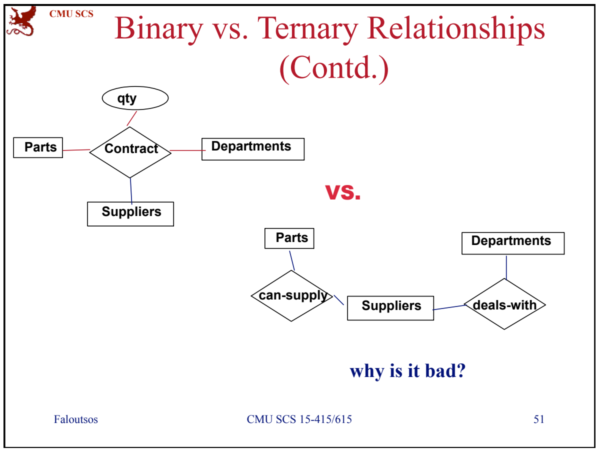
Binary vs Ternary Rel.

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



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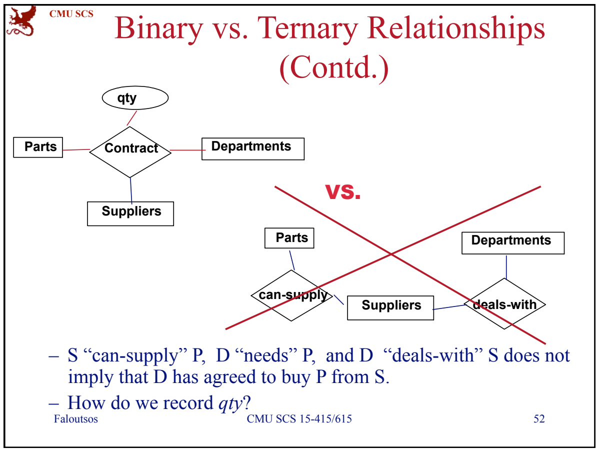
Binary vs. Ternary Relationships (Contd.)

why is it bad?



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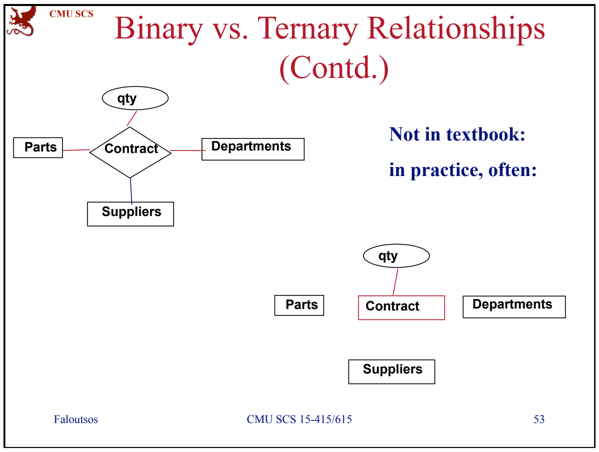
Binary vs. Ternary Relationships (Contd.)

- 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*?



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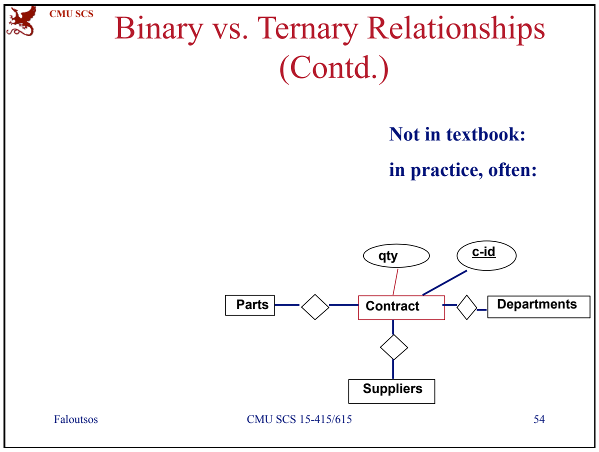
Binary vs. Ternary Relationships (Contd.)

Not in textbook:

in practice, often:



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Binary vs. Ternary Relationships (Contd.)

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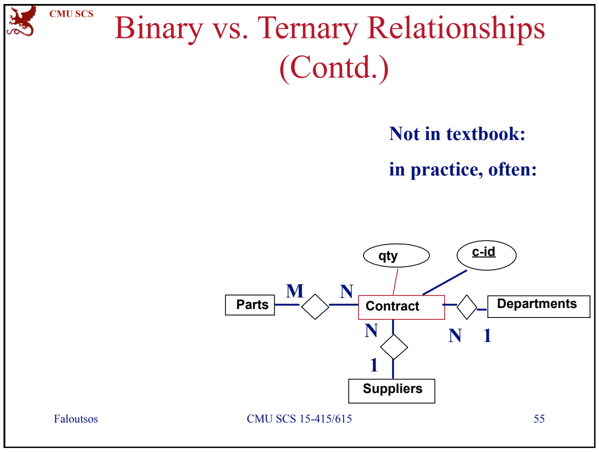
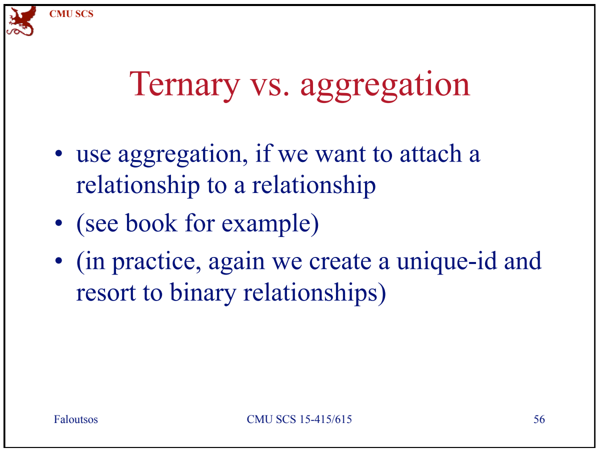


CMU SCS

Binary vs. Ternary Relationships (Contd.)

Not in textbook:

in practice, often:



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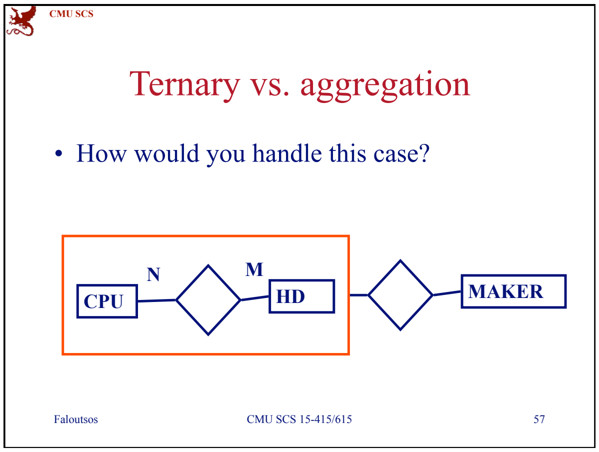
Ternary vs. aggregation

- 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)



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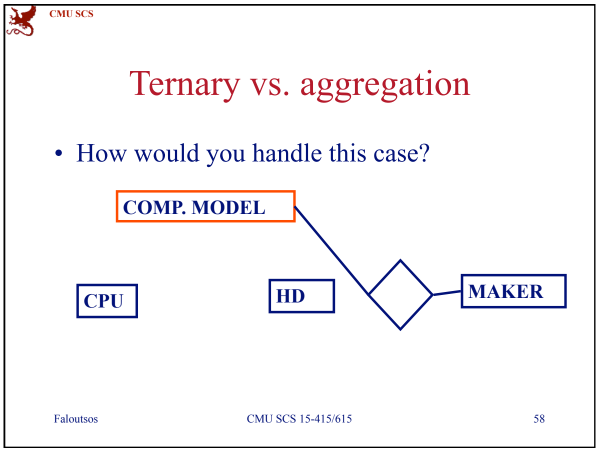
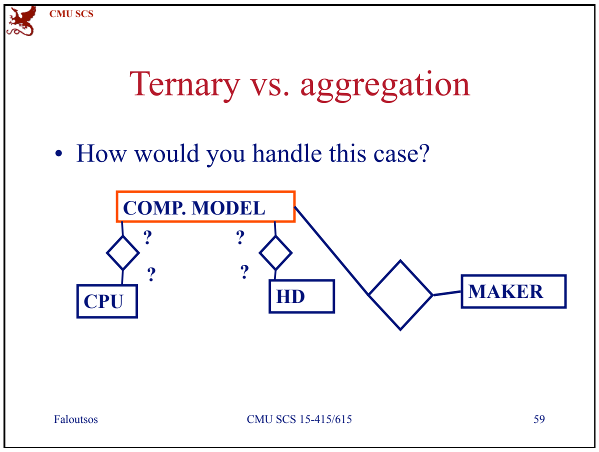
Ternary vs. aggregation

- How would you handle this case?



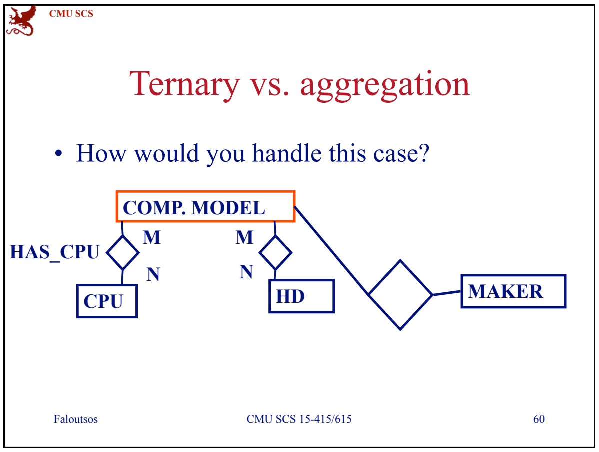
Ternary vs. aggregation

- How would you handle this case?



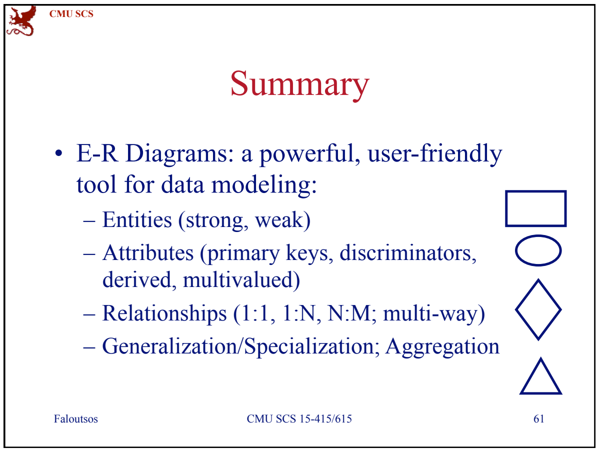
Ternary vs. aggregation

- How would you handle this case?



Ternary vs. aggregation

- How would you handle this case?



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

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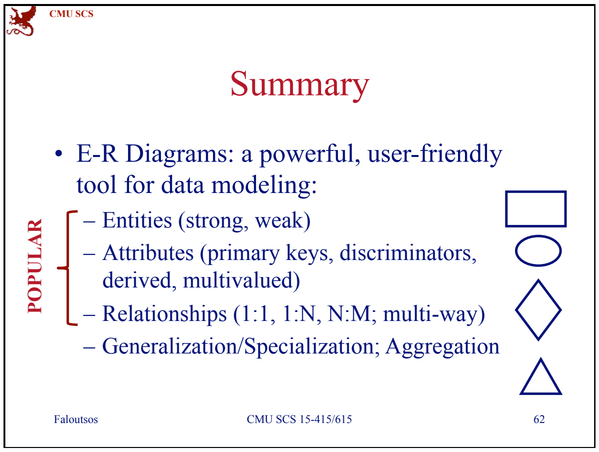

CMU SCS

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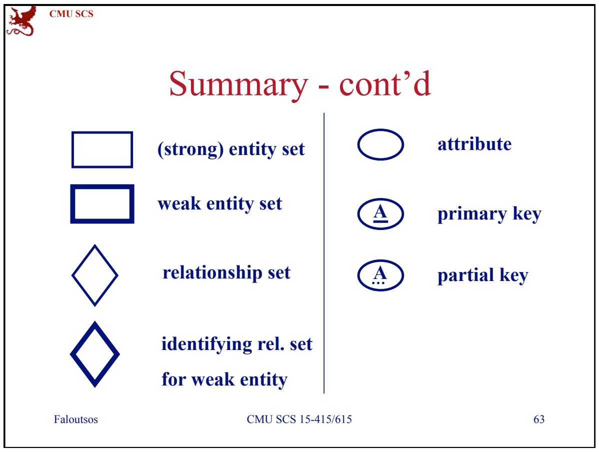
Faloutsos CMU SCS 15-415/615 62



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Summary - cont’d

(strong) entity set

weak entity set

relationship set

identifying rel. set for weak entity

attribute

primary key

partial key

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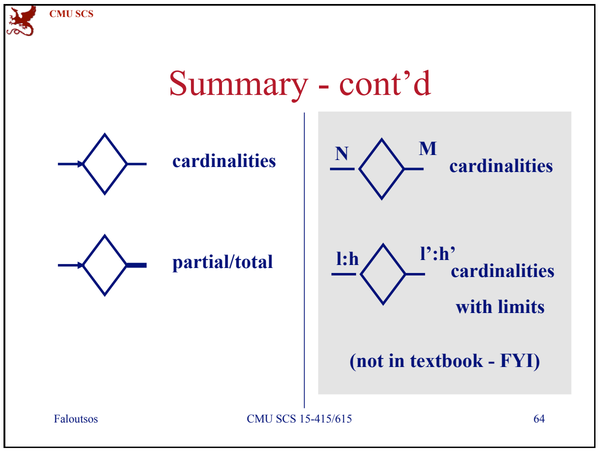

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Summary - cont'd

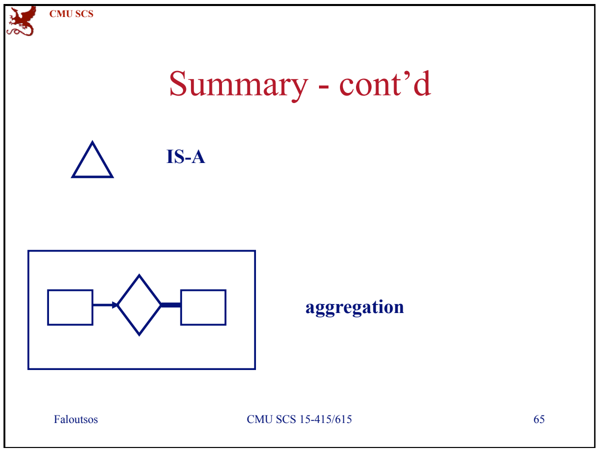
cardinalities

partial/total

N M cardinalities

l:h l':h' cardinalities with limits

(not in textbook - FYI)



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Summary - cont'd

IS-A

aggregation