

- Library organized into sections, like art, children, computing, science, etc. Each section has name and a number and is managed by a head librarian
- Each book title belongs to a section and has a title, authors, ISBN, call number, year and publisher
- For each copy of the book keep track the current borrower, the due date and the librarian who charged it out
- Members have membership number, a driver's license, an address, a phone number and birthday.
- Members can have up to 5 borrowed books and can put a hold request on a book
- □ Librarians have a name, ssn, address, phone

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### Observation

nouns -> entity types/sets

verbs -> relationship types

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28

### Case Study: Library Database System

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29

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### Library organized into sections, like art, children, computing, science, etc. Each section has name and a number and is managed by a head librarian Assumptions 1. Name: {art, children, computing, science, ?} 2. Specify the types of all attributes 3. Each section is managed by one head librarian, vice versa Name(First, MI, Last) Phone Note that in our case study we use dots to represent attributes instead of ovals for space limitations. This is also the case in same CASE tools.

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34

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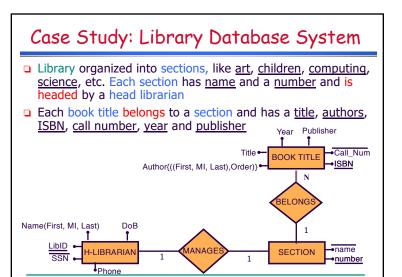
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40

### Case Study: Library Database System

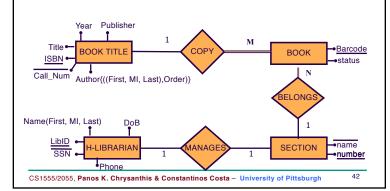
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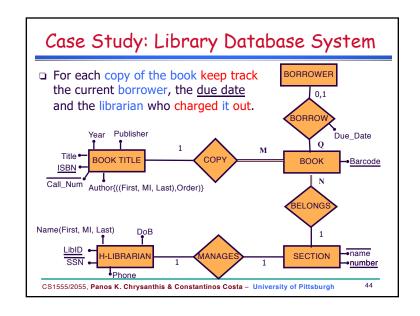
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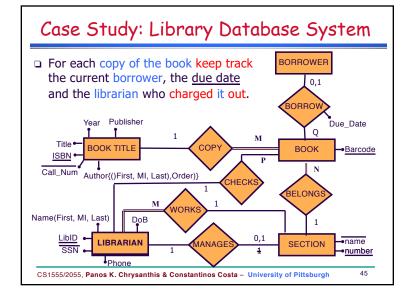
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□ For each copy of the book keep track the current borrower, the due date and the librarian who charged it out.



## For each copy of the book keep track the current borrower, the due date and the librarian who charged it out. | Section | Publisher | Copy | BOOK | TITLE | BOOK | TITLE | BOOK | Section | Section





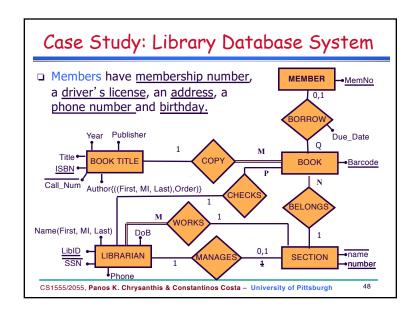
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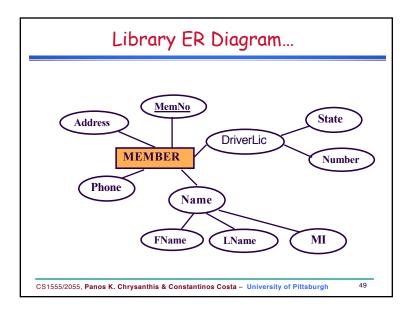
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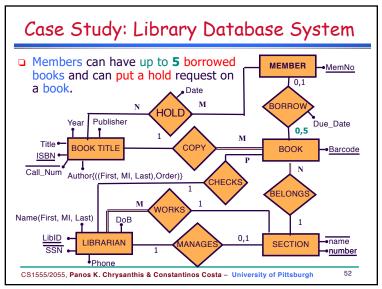
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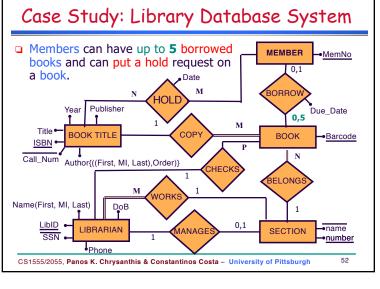
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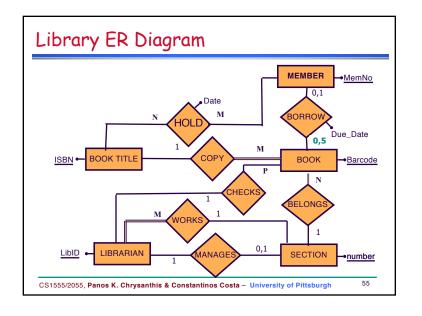


### Library ER Diagram MEMBER •MemNo 0,1 BORROV Publisher Due Date 0,5 BOOK Barcode Call\_Num Author{((First, MI, Last),Order)} BELONG Name(First, MI, Last) 0,1 •name **SECTION** number CS1555/2055, Panos K. Chrysanthis & Constantinos Costa - University of Pittsburgh

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# Address MemNo Address DriverLic Number Phone Name LName MI CS1555/2055, Panos K. Chrysanthis & Constantinos Costa - University of Pittsburgh 57

### Entities

- TITLE: CallNumber, Name, Author{(Name(Fname, MI, Lname),Order)}, <u>ISBN</u>, Year, Publisher;
- MEMBER: MemNo, DriverLic(State,No), Name(Fname, MI, Lname), Address, PhoneNumber;
- 3. **BOOK**: BookID, Status, Edition;
- LIBRARIAN: <u>SSN</u>, Name, Address, Salary, Gender, Date of Birth;
- 5. SECTION: SectNo, Name;

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### Weak Entity

- Assume the additional requirement that all the dependents of each librarian are stored in the DB
- 1. **DEPENDENT**: Name, Date of Birth, Kinship

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### Relationships

- COPY: <TITLE, BOOK> 1:M, PARTIAL/TOTAL;
- BELONGS: <BOOK, SECTION> N:1,TOTAL/PARTIAL;
- 3. **HOLD**: <MEMBER, TITLE> M:N, PARTIAL/PARTIAL, Date;
- BORROW: <MEMBER, BOOK> 1:5, PARTIAL/PARTIAL, BorrowDueDate;
- CHECKS: <LIBRARIAN, BOOK> 1:N, PARTIAL/PARTIAL;
- 6. **MANAGES**: <LIBRARIAN, SECTION> 1:1, PARTIAL/PARTIAL;
- 7. **WORKS**: <LIBRARIAN, SECTION> 1:N, TOTAL/PARTIAL;
- DEPENDS: <LIBRARIAN, DEPENDENT> 1:N, PARTIAL/TOTAL;
- SUPERVISES: <supervisor-LIBRARIAN, supervisee-LIBRARIAN> 1:N, PARTIAL/PARTIAL;

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### Assumptions/Clarifications:

- One author writes one or more titles.
- Several co-authors write one or more titles.
- A book is a copy of a title. A title can have one or more copies of the book.
- A book has a unique id (not a copy id). If a copy id is used then book is a weak entity type.
- □ A particular member places a hold on a particular title.
- Not all members necessarily borrow books. Not all books are necessarily borrowed.
- Not all titles need necessarily be of books. However, all books must have a title and only one title.

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61

### Conceptual Database Design & FR-Model

- ◆ ER-Model
- ◆ ER-Diagrams
- ◆ EER Model & Diagrams

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### EER Model: Enhanced ER Model

- The **EER** model introduced the concepts of *superclass* and *subclass* entity types in the ER model
  - MEMBER (superclass):
    - LIFE-MEMBER, REGULAR-MEMBER, and SEASON-MEMBER (Subclasses)
  - LIBRARIAN (superclass):
    - HEAD LIBRARIANS, SALARY LIBRARIANS, and HOURLY LIBRARIANS (subclasses)

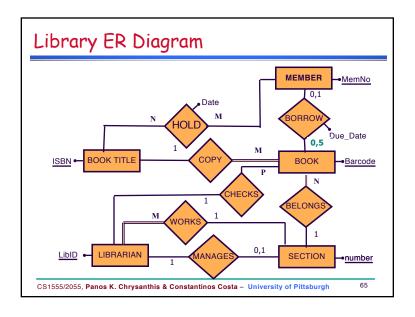
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63

### Why EER Model?

- To add more semantic clarity to the design
- E.g., if only salary-librarians can belong to the librarian quild, then this can be expressed as
  - BelongTo:<SALARY-LIBRARIAN, LIB-GUILD> and not as
  - BelongTo:<LIBRARIAN, LIB-GUILD>
- Minimize NULL values

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### Specialization, Generalization, Inheritance

<u>Specialization</u>: identifying subclasses, and their distinguishing characteristics (attributes & relationships)

(Top-down design)

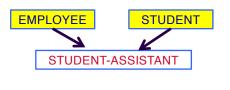
 Generalization: aggregate entities to a superclass entity type by identifying their common characteristics

(Bottom-up design)

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### Specialization, Generalization, Inheritance

- □ <u>Inheritance</u>: IS\_A (instance) relationship that supports attribute inheritance and relationship participation
  - Single inheritance results in a hierarchy
  - Multiple inheritance results in a lattice

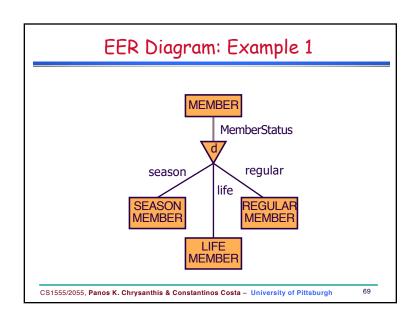


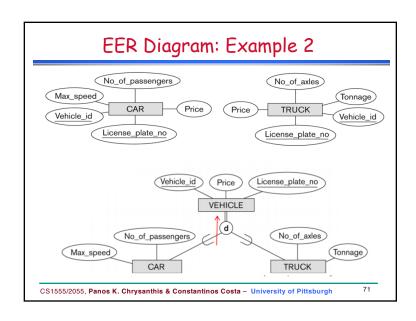
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### Inclusion Constraints

- <u>The disjoint constraint</u>: the subclasses of a superclass are disjoint.
  - This means that an entity can be a member of only one subclass.
  - The entities for each class can be *user-defined* or specified with a *predicate-defined subclass*.
  - In a predicate-defined subclass, we use a selection condition on one or more attributes to define the entities of the subclass. E.g., MembershipStatus
- <u>The non-disjoint constraints</u>: specify that the subclasses are overlapping and an entity may be a member of more than one subclass.

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### Completeness Constraints

- A total specialization: specifies that every entity in the superclass must be a member of some of its subclasses
  - E.g., a librarian must belong to one of the subclasses of LIBRARIAN.
- A partial specialization: specifies that an entity may not belong to any subclass
  - E.g., an honorary member may not belong to any of the specializations (subclasses) of MEMBER.
- Superclass via generalization is always total

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